MECHANICS' MAGAZINE,

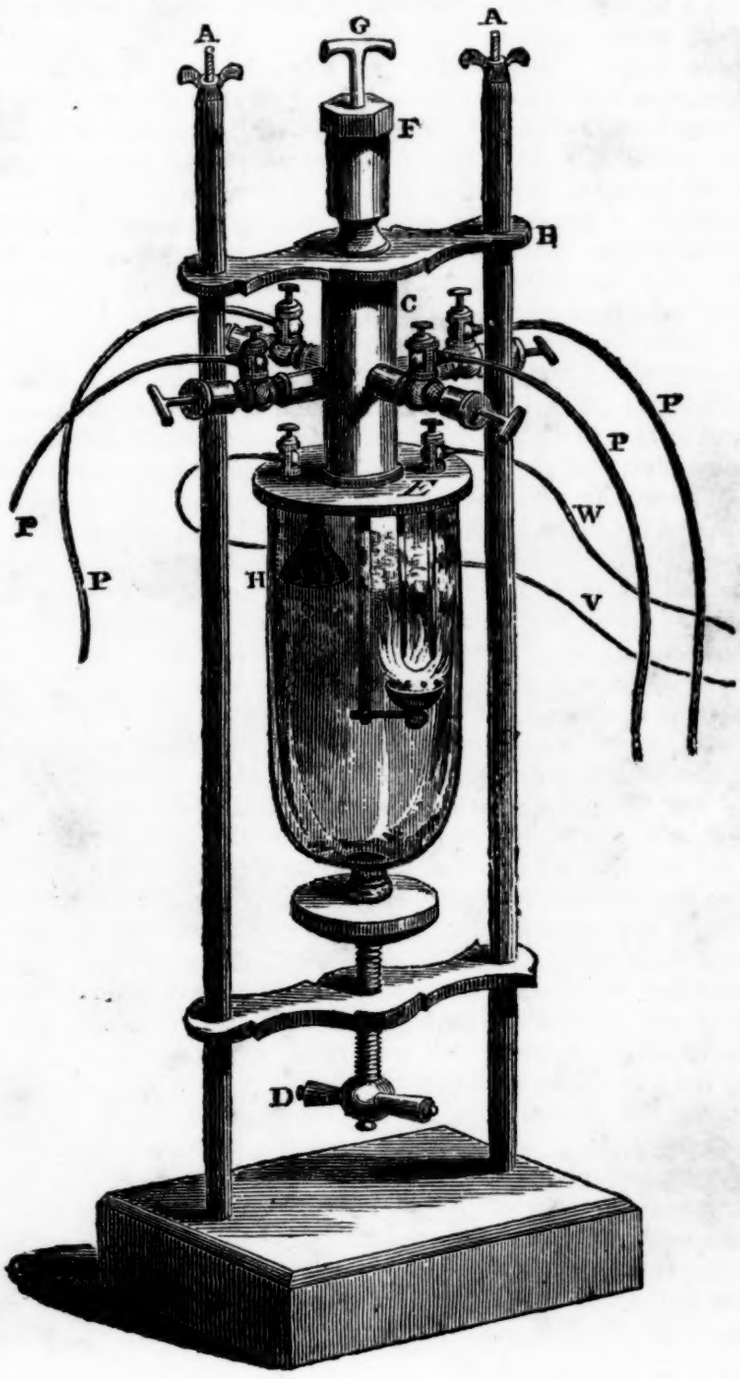
AND

REGISTER OF INVENTIONS AND IMPROVEMENTS.

VOLUME II.] DECEMBER, 1833. [NUMBER 6.

Read not to contradict and confute, nor to believe and take for granted, nor to talk and find discourse, but to weigh and consider.—BACON.

Apparatus for evolving Silicon from Fluo-Silicic Acid Gas.



Apparaus and Processes, by Robert Hare, M. D., Professor of Chemistry in the University of Pennsylvania. [Communicated by the Author.]

1. Apparatus for evolving Silicon from Fluo-silicic Acid Gas.—Into a stout mahogany block as a basis, two iron rods, A, A, are so planted as to extend perpendicularly, and of course parallel to each other, about two feet in height. Upon these rods two iron bars are supported horizontally, one, B, near their upper extremities, the other at the height of about six inches from the wooden basis. In the centre of the lower bar there is a screw, D, having a handle below the bar, and supporting above it a circular wooden block. Into a hole in the upper iron bar, equi-distant from the rods, is inserted a hollow brass cylinder, C, which at the lower end screws into an aperture in a circular plate of brass, E, which is thus supported horizontally a few inches below the bar. By these means room is allowed for the insertion into the cylinder of four valve cocks, each furnished with a gallows screw. The cylinder is surmounted by a stuffing box, through which a copper sliding rod, G, passes air tight. The brass plate is turned and ground to fit a bell-glass of about five inches in diameter, and eight inches in height, which is pressed up when necessary between the plate and the block by the screw D, supporting the block. Within the space comprised by the bell-glass, and on one side of the centre of the plate, two stout brass wires are inserted, one of them insulated by a collet of leathers, so as to admit of the ignition, by a galvanic discharge, of a small arch of platina wire, which terminates them. The sliding rod, above-mentioned as occupying the stuffing box, terminates below the plate in an elbow, which supports a cap at right angles to the rod, at the same distance from the rod as the platina wire, and on the opposite side of it there is a brass cover, H, for the cap, supported from the plate. The arrangement is such that, by a suitable movement in the sliding rod, made by grasping it by the handle G, in which it terminates externally, the cup may be made either to receive into its cavity the platina wire, or to adjust itself to its cover, H.

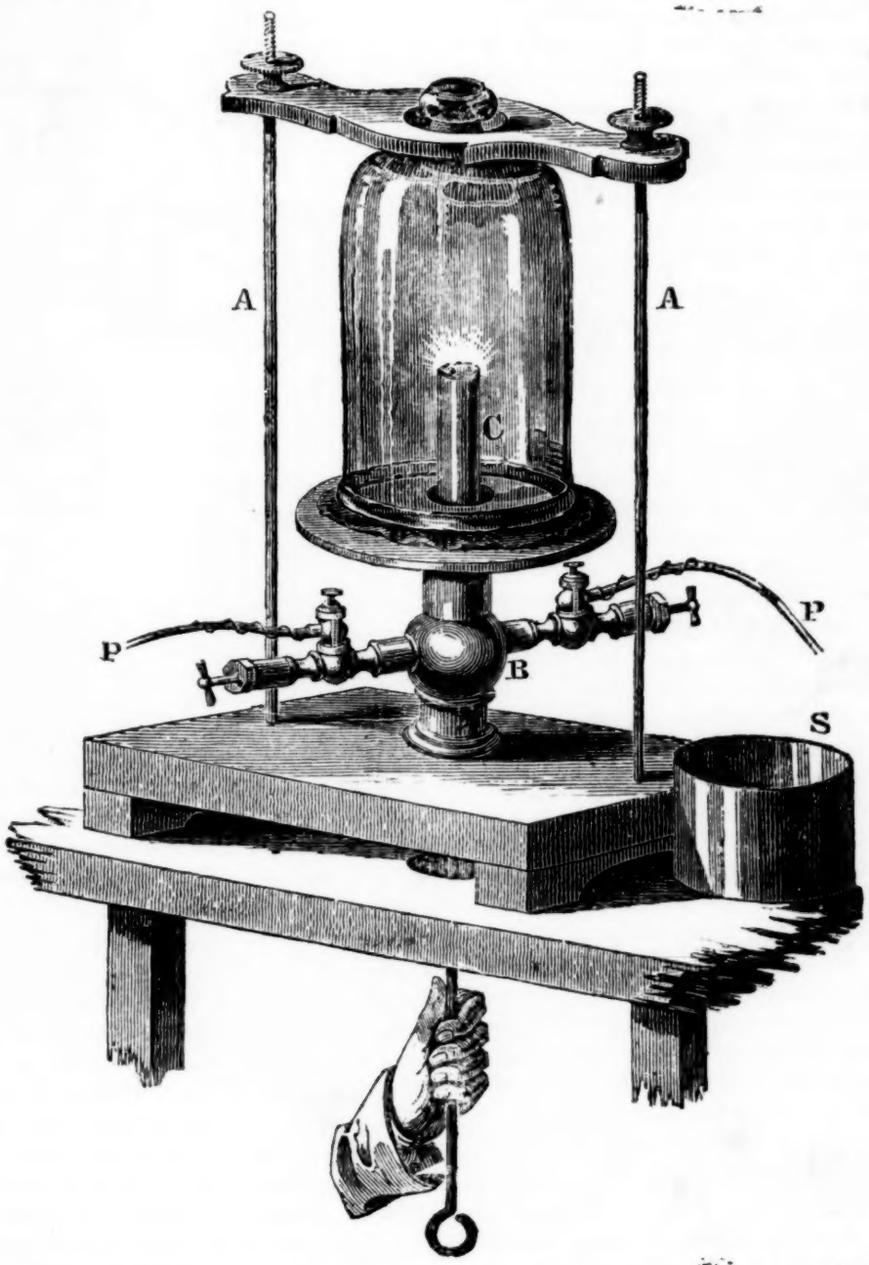
The bell being removed, about sixty grains of potassium, in pieces not exceeding more than fifteen grains each, are to be introduced into the cup, which is then to be adjusted to the cover, and the bell secured. In the next place, by means of the flexible lead tubes, P, P, P, P, and the gallows screws attached to the valve cocks, establish a communication severally with an air pump, a self-regulating reservoir of hydrogen, a barometer gage, and a jar over the mercurial cistern containing fluo-silicic acid gas. First, by means of the air pump exhaust the bell, and in order to wash out all remains of atmospheric air, admit hydrogen from the reservoir. Again exhaust, and again admit hydrogen. Lastly, exhaust the bell of hydrogen and admit the fluo-silicic acid gas. By means of the gage the exhaustion is indicated and measured, and by the same means it will be seen when the pressure of the gas within the bell approaches that of the atmosphere. When this takes place, the cocks being all closed, by means of a calorimotor, the platina wire is to be ignited, and the potassium brought into contact with it.

A peculiar deep red combustion ensues, evolving copiously chocolate colored fumes, which, condensing into flocks of the same hue, subside throughout the receiver, (excepting the color,) like snow in miniature. On removing the bell after the potassium is consumed, the cup which held it will be found to contain silicon, mixed with the fluoride of potassium, and with this indeed the whole of the powder deposited is contaminated. Silicuret of potassium is likewise formed in the cup, since on the affussion of water a fetid evolution of silicuretted hydrogen ensues. By repeated infusions, first in cold, and afterwards in boiling water, agreeably to the directions of Berzelius, the silicon is left in the state of a brownish ash-colored powder.

Thus obtained, silicon does not appear to be acted on either by sulphuric, nitric, fluoric, or muriatic acids; nor when exposed to nitrate of potash, liquified by heat. It seems to be soluble for the most part in a mixture of nitric and fluoric acid, which by analogy we called nitro-fluoric acid; but after exposure for 18 hours to this solvent, a small portion of a black matter remained undissolved. This is, in all probability, carbon derived from the potassium, which, according to Berzelius, when obtained by Brunner's process, is liable to be combined with carbon. The solution of nitro-fluoric acid, decanted from the residual black powder into a solution of pearlash, gave a copious, white, gelatinous precipitate like silex, which, when thrown into a large quantity of water, subsided undissolved. When on subjecting the silicon to red hot nitrate of potash, anhydrous car-

bonate of the same alkali was added, so as to co-operate with the nitre, an explosive effervescence took place. All the silicon disappeared, and a compound resembling the silicate of potash was produced. This anomalous re-action may be considered as characteristic of silicon.

The impression that the black matter insoluble in the nitro-fluoric acid was carbon, is confirmed by the fact, that after the silicon had been digested for some hours in strong nitric acid, and finally boiled in it to dryness, it dissolved in nitro-fluoric acid without any such residuum.



2. Improved Process for the Evolution of Boron.—By means of an apparatus represented by the annexed engraving, I have succeeded in evolving boron by the reaction of potassium with vitrified boracic acid in vacuo, without encountering the evil of any explosive action, to which the process, as heretofore conducted, in pleno, has been found liable.

A circular brass plate is prepared, like the plate of an air pump, so as to produce, with any suitable receivers properly ground, an air-tight juncture. It is supported on the upper end of a hollow brass cylinder, B, with the bore of which it has a corresponding aperture. The brass cylinder is about three inches in diameter, and six inches in height, being inserted at its lower end into a block

of wood as a basis. This cylinder receives below, a screw, which supports a copper tube, C, of about two inches in diameter, so as to have its axis concentric with that of the cylinder, and to extend about four inches above the plate. The copper tube thus supported is closed at the upper termination by a cup of copper, of a shape nearly hemispherical, and soldered at the upper edge to the edge of the tube; so that the whole of the cavity of the cup is within that of the tube. Hence the bottom of the cup is accessible to any body not larger than the bore of the tube, without any communication arising between the cavity of the tube, and that of any receiver placed upon the plate, over the cup and tube, as in the figure.

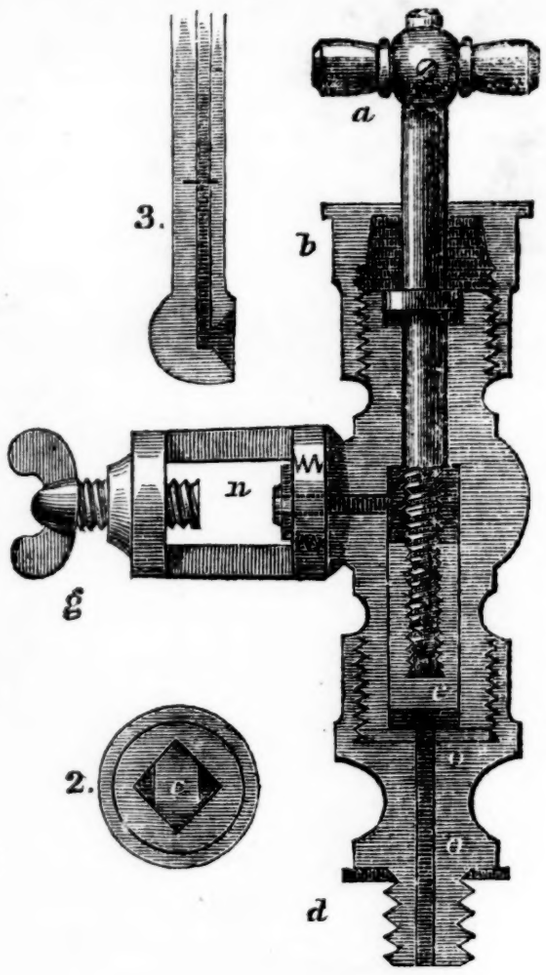
Into the side of the cylinder supporting the plate, a valve cock is screwed, by means of which, and a flexible leaden tube, a communication with an air pump is opened, or discontinued, at pleasure.

The cup being first covered with a portion of the vitrified boracic acid, as anhydrous as possible, and finely pulverized, the potassium is introduced, and afterwards covered with a further portion of the same acid, two parts of the potassium being used for one of the acid. A large glass receiver is now to be placed on the plate, secured by rods, A, A, concentric with the tube and cup; from the heat of which the glass is to be protected by a bright cylinder of sheet brass, S, placed around it so as to be concentrical with the receiver and tube.

The apparatus being so prepared, and the receiver exhausted of air by means of the air pump, an incandescent iron is introduced through the bore of the tube, so as to touch the bottom of the copper cup. In a short time a re-action commences, which aiding the influence of the hot iron, renders the cup and its contents red hot. A deep red flame appears throughout the mass, after which the re-action lessens and the heat declines.

When the cup has become cold, the air is admitted into the receiver and the contents are washed with water. If any of the acid has escaped decomposition, it may be removed by boiling the mass with a solution of potash or soda. After this treatment and due desiccation a powder will remain, having the characteristic color and properties of boron.

The additional valve cock, represented in the figure, gives the option of introducing dry hydrogen for the purpose of washing out atmospheric air, as described in the process for silicon.



3. Description of the Valve Cock, a perfectly air-tight Substitute for the common Cock, alluded to in the preceding Articles.—This figure is intended to illustrate the construction of a substitute for a common cock, which I have been accustomed to call a valve cock. It was devised by me about twenty years ago, among a number of other analogous contrivances, and seems upon the whole less liable to fail than any other which I have tried. The engraving represents a longitudinal section of the valve cock. At *a* is a piston with a collar enclosed in the stuffing box *b*, so as to be rendered air-tight by means of oiled leather. Hence the piston may be turned or made to revolve on its axis, while incapable of other motion. Upon the end of the piston a thread for a screw is cut, which fits into a female screw in the brass prism *c*, so as to cause this prism to approach to, or retreat from a bearing, covered by leather, in the centre of which there is a perforation, *o o*, communicating with one of the orifices of the instrument. This orifice is surrounded by the

male screw *d*, so that by means of this screw the valve-cock may be fastened into an appropriate aperture, properly fitted to receive it, subjecting an interposed leather to such pressure as to create with it an air-tight juncture. The prism *c* has two of its four edges cut off (see fig 2) so as to allow a free passage by it, reaching to the lateral perforation terminating in another orifice, over which there is a gallows screw, *g*. By means of this gallows screw, when requisite, a brass knob, such as that represented by fig. 3, soldered to a leaden pipe, may be fastened to the valve cock. The juncture is rendered air tight by the pressure of the screw in the gallows, upon a leather which is kept in its place by means of the nipple *n*.

The method last mentioned of producing an air-tight juncture, was contrived by me about seven years ago, and proves to be of very great utility. There is no other mode with which I am acquainted, of making a perfectly air-tight communication, between the cavities previously separated, at all comparable to this in facility.

On destroying the Bad Effects of Smoke from Wood, Coal, &c. By Watson Farris. To the Editor of the Mechanics' Magazine, and Register of Inventions and Improvements.

Sir,—I have recently ascertained by experiment on light, heat, &c. that by a very simple constructed furnace, I have succeeded in destroying all the bad effects of smoke raised from wood, coal, or other fuel, and thinking it may be beneficial when applied to steam carriages, I am induced to write to you for information, as my business will not allow me to visit the city of New-York very soon. You will excuse me for addressing you on the subject, as I have not sufficient knowledge of steam carriages, or of the people who are interested in them, to pursue a more proper course; and you will confer a favor on me, whether the improvement is beneficial or not, to give me a letter in answer as soon as convenient. Respectfully, Watson Farris.

Nantucket, 11mo. 15, 1833.

[If our correspondent has accomplished the construction of such a furnace as he describes, he will render an essential service to the world by taking measures to bring his invention into immediate practical operation. If he purposes to secure a patent, we advise him to do it forthwith; and when we can publish a full description of it, with such drawings as may be necessary, without prejudice to his interest, we shall gladly do so, if he will favor us with them.—Ed. Mec. Mag.]

A Capital Suggestion.—The writer of a pleasant and ingenious article in the Medical Magazine, entitled Medical Chit-chat, addressing himself to the editor, asks, "Does it ever strike you how much our manufacturers or owners of steam engines might increase public comfort and health, by the simple process of attaching vapor bath rooms to their waste steam-flues? Every puff of this wasted steam would make a bath for a limb, and several would fill a box capable of containing some dozen persons, sitting, in the fashion of vapor baths in Russia and Turkey. On board steamboats on the Mississippi, they would be highly advantageous. The steam necessarily wasted there is enough for a perpetual bath, day and night. Whenever voyages on the ocean are common in steamships, this will be thought of. The vapor bath which failed some time ago, in Boston, was at too high a price. Thousands, especially of laborers, who get begrimmed and sooty in the week, would pay six or twelve cents a week for the privilege of using this steam, now wasted, and which might be afforded at this price. Luxury might have its champooners, its heating rooms, and couches, and oil, and coffee. Labor would be better pleased with a simple soaking for six cents. I am confident it could be afforded at that price, wherever steam engines are at work. In Birmingham it would suppress intemperance, for bathing has a wonderful effect in soothing the irritation of the stomach, and bowels, and head, and heart, and skin, on which grog-selling thrives. We are temperate enough, but not too clean, in the United States; that is, we are the most temperate northern nation."—[Boston Evening Transcript.]

Public Observatory.—A correspondent, who signs himself "A Man of Kent," says, "Last week, for a shilling, I was able to make acquaintance with an aquatic world, whose existence I, till then, had never been aware of. The 'Hydro-oxygen Microscope' convinced me that a dew-drop may be as full of moving beings as Almack's. But I have been all my life—or half my life—that is, all the nights of it,—desiring a nearer acquaintance with the stars; and I wish that my honest shilling could procure me admission to some observatory, where I could contemplate those enormous evidences of the Creator's power with as much ease as I did the minute atoms whose existence I had never known of before." The hint appears to

us well worthy the attention of those who have capital and enterprise. We have little doubt that the prevailing desire for knowledge would render a cheap observatory one of the most attractive objects in the metropolis.

New Writing Paper.—A new writing paper has just been introduced, which, by means of a chemical operation it undergoes, has the singular property of becoming perfectly black whenever it is touched with any fluid. It is only necessary, therefore, to write on this paper with a pen dipped in clean water, to produce a distinct and legible communication.—[London paper.]

Professor Henry's Magnet.—An artificial magnet has recently been constructed by Professor Henry, of Princeton College, which far surpasses in power every thing of the kind. A number of interesting experiments on the subject of electro-magnetism, were exhibited by means of this wonderful instrument, in the presence of the students, and a large number of gentlemen assembled to attend the commencement.

Upon one trial of its strength, it was found to be capable of raising between three and four thousand pounds, and we learn that, with some farther modifications of the apparatus, the magnet will probably be able to sustain upwards of four thousand pounds.

Professor Henry has also made important improvements in the construction of the galvanic battery, when it is to be applied to the production of a magnetic power. The particulars of his improvements we are unable to explain, but, for the sake of science, we hope that this gentleman will soon give to the public a full account of the improvements, and of their important results.—[New-York Standard.]

Air Power.—A power, which has never been applied in mechanics to any useful purpose, save that of turning wind-mills, (a very inferior application, when water or steam can be afforded,)—we mean the power of air—is likely, by some accounts, to supersede both steam and water. And it is a little singular that the new mode of applying this power suggested itself almost simultaneously to two persons, separated by an ocean three thousand miles wide. Mr. Ericsson, of London, has, it seems, taken out a patent for an improved method of applying *heated* air, by which he proposes to make a saving of eight-tenths of the fuel now consumed in generating steam. An engine of one horse power has been kept in operation, by this means, during three months, with complete success. As if, however, in all great improvements in the application of mechanical power, Yankee ingenuity were destined to excel that of all other nations, Mr. Treadwell, of Boston, comes forward with a plan so to compress and exhaust air as to make it answer all the purposes of steam; the result being equally brilliant with that of Mr. Ericsson's, while the means used show a still greater triumph of art. Mr. Treadwell proposes to dispense with both boilers and heat! Whether or not, in economy of application, Mr. Treadwell's be the greater improvement, we do not know. We infer that it is: for we cannot conceive how the first cost of the apparatus, to be employed by Mr. Treadwell, or the expense of working it, can compare with the first cost of steam engines and the heavy charges for the supply of fuel. And supposing it to be as safe, as we presume it is economical, the improvements of Mr. Treadwell may be considered the *ne plus ultra* in the application of mechanical power.

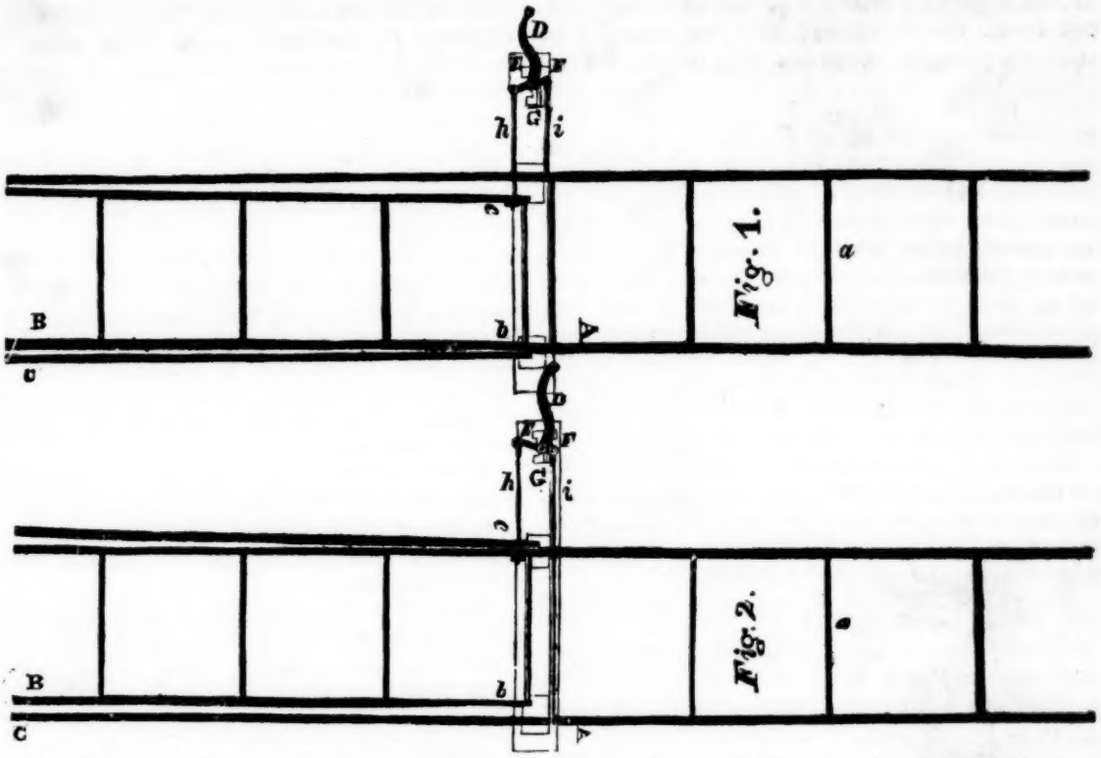
On the Proximate Causes of Winds and Storms.—The four following propositions may be regarded as statements of general facts, which have been sufficiently established by numerous observations in various parts of the world.

1st. That part of the great ocean which lies between the thirtieth parallel of latitude on both sides of the equator is constantly swept by a wind varying but a few points from the east.

2d. Between the latitudes of 30 and 60 degrees, in both the northern hemispheres, westerly winds predominate over those from the east quarter, in a ratio probably somewhat greater than that of three to two.

3d. There is in all latitudes (a few trades of limited extent where local causes have a decided effect excepted) a predominance of winds blowing from the poles towards the equator, over those moving in the opposite direction, but this predominance is not so well marked and decided as that of the westerly over the easterly winds, between the latitudes of 30 and 60 degrees.

4th. During the warm weather within the temperate, and at all seasons within the limits of the torrid zone, the fall of rain is often accompanied by lightning, thunder, and violent winds, constituting what is commonly called a thunder-storm. Thunder-storms generally commence between mid-day and sun-set, and move from west to east.—[Prof. Mitchell.]



Plan for Railroad Turnouts. [Communicated by the Inventor for the American Railroad Journal, and Advocate of Internal Improvements.]

The advantages that this plan of turnout has over the various plans now in use consist in the great diminution of curvature, viz. instead of moving the portable end of the bars, A A, sufficiently to form a connection with the double track, which must be sufficient to give clearance to the flange of wheels between the rails, as in the present mode, the rails A A move only one inch, and, as per description of diagram, one rail of the turnout and one of the single track move alternately into its place, to form the required connection with the bars A A, and out of its place to give clearance to the flange of wheels; the objection to the bars *b* and *c* being loose at one end is overcome by the wheels taking a bearing upon the permanent rail of the track, laying alongside of and nearly parallel.

A A are the portable bars, or switches, on the single track; B B are bars of the same track; and C C are the bars terminating or commencing a double track. A A connect by means of cross rods *a a a a*, *b c* are connected by cross rods, and are portable at one end in like manner to A A; the cast iron arch G, the levers E E, and the vertical shaft F, are the apparatus for working the different bars by means of the connecting rods *h i*. It may be necessary to mention that E is a double lever, and the proportion from F to either end is as one is to three. *b* and *c* compose one bar of each track, and are connected to the long end of the lever E by the connecting rod *h*. A A form bars of both tracks according to their different positions, and are connected to the short end of the lever E by the connecting rod *i*. It will readily be perceived by a reference to the diagram that, by moving the lever D, fig. 1, in the position of D, fig. 2, D and E being both permanently fixed upon the vertical shaft F, which passes through the cast iron arch G, you will move the bars A A to connect with the double track, and at the same time move the bar *c* into its proper place, which, being connected with the bar *b*, is drawn out of its place, to give clearance to the flange of the wheels, and by moving the lever D in the position of fig. 1, you bring A A back in their original positions; you move *b* against the bar C in its working position, and move *c* out of its place, to give clearance to the flange of the wheel. The bars A A have been calculated in the diagram to diverge one inch from a straight line, and by running the same curvature regularly from a tangent, the permanent end of the bar *c*, or C C, will diverge four inches from a straight line—that is, calculating the bars to be 16½ feet long by 2 inches wide—and will give 2 inches clearance for flanges of wheels and a curvature of a fraction over 2° 15′.

An Investigation of a Formula for calculating the Transfer of Water from one Level to another, by the Lockage of Boats in Canals. By S. C. Walker. [From the Journal of the Franklin Institute.]

The natural tendency of fluids towards a level, or state of equilibrium, renders it easy to transfer water from the summit level to the lowest level, by the simple opening of gates.

When there is a scarcity of water in the summit level, the deficiency may be supplied by stationary steam engines, and the loss from evaporation, leakage, and other causes, provided for. It is an inquiry of importance whether there may not sometimes be, in the circumstances of the country through which canals pass, natural means, of which advantage can be taken to effect a transference of water from the lowest to the summit level. Should such means present themselves, the expediency of using them to effect this transfer, in any proposed canal, would be determined by an estimate of the expense of locks adapted to the purpose, of the time lost by lockage, and the value of the water thus raised to the summit level, or omitted to be drained away.

With these statistics, the present inquiry has no concern, its object being to ascertain whether such transference is possible in any instance, and if so, in what instances, and under what circumstances it is possible.

Make l' = the length, in feet, in the clear of a lock.

l'' = the average length, in feet, of a boat.

w' = the width, in feet, in the clear of a lock.

w'' = the average width, in feet, of a boat.

d' = the difference, in feet, of the levels above and below the lock.

d'' = the average depth, in feet, of the water displaced by the boat going from the upper to the lower level.

d''' = the same for the boat returning from the lower to the upper level.

m = the factor by which a cubic foot of water must be multiplied to obtain its weight in parts of a ton avoirdupois.

Then $m\ l'\ w'\ d'$ = the tons of water required to raise the water in the lock from lower to upper level.

$m\ l''\ w''\ d''$ = the tonnage of the boat descending.

$m\ l''\ w''\ d'''$ = the tonnage of the boat ascending.

In canals where there are no lateral reservoirs,

$m\ l'\ w'\ d'$ = the constant loss of water transferred from upper to lower level by locking a boat in either direction.

$m\ l''\ w''\ d''$ = the tons of water transferred upwards by the descending boat, by virtue of the fixed gates used as fulcra. These tons are first transferred above the upper gates by admission of the boat into the lock, by virtue of the fixedness of the lower gates; the contrary supposition involving the absurdity of maintaining that the lock receives the addition of $m\ l''\ w''\ d''$ tons without raising the level. The same amount $m\ l''\ w''\ d''$ tons is again transferred from the lower level into the lock, by the removal of the boat below the lower gates, by virtue of the fixedness of the upper gates. The contrary supposition involves the absurdity of maintaining that one horse can by his single strength elevate a number of tons, $m\ l''\ w''\ d''$, through a height d'', without any mechanical advantage.

The same reasoning may be applied to the ascending boat.

$m\ l''\ w''\ d'''$ = the tons transferred from the lock to the lower level by admission of the ascending boat, by virtue of the fixedness of the upper gates, and again transferred from the upper level to the lock by removal of the boat upwards, by virtue of the fixedness of the lower gates. The contrary hypothesis involving similar absurdities.

It will now be easy to deduce a formula for expressing the transfer of water by the two operations of locking a boat downwards and upwards, whatever be the load of the boat in either direction.

Make T = the number of tons thus transferred from one level to the other by this double operation, the positive value being upwards from lower to upper level, the negative value downwards from upper to lower level.

$$T = m\ (l''\ w''\ d'' - l''\ w''\ d''' - 2\ l'\ w'\ d')\ldots\ldots(1)$$

$$= m\ \{l''\ w''\ (d'' - d''') - 2\ l'\ w'\ d'\}\ldots\ldots\ldots\ldots(2)$$

Make p = the factor by which l'' must be multiplied to equal l'.

g = similar factor for w'' to produce w'.

Then
$$p\ l'' = l'$$
$$g w'' = w'$$

Substituting the values of l' and w' in (2)

$$T = m\{l''\ w''\ (d'' - d''') - 2\ p\ q\ l''\ w''\ d'\}$$

$$= m\ l''\ w''\ (d'' - d''' - 2\ p\ q\ d')\ldots\ldots\ldots(3)$$

In this formula the conditions to be fulfilled in order that T may be positive, in other words that there be a net transfer from the lower to the upper level, is that $d'' > (d''' + 2\ p\ q\ d')$. This is manifestly possible; for by constructing the boat to fit closely to the sides and end of the lock, $2\ p\ q$ may be diminished at pleasure, and d' may be taken of any amount, however small. In practice the natural limit to the smallness of d' depends upon the cost of locks and the value of time lost in lockage through a multiplicity of locks; d''' may be the depth of water displaced by an empty boat, d'' by a loaded boat; in such an instance the above conditions may be verified, even without lateral reservoirs for diminishing the loss from difference of level.

The same formula will readily enable us to calculate the transfer of water in those canals whose locks are provided with lateral reservoirs.

Make a = the factor by which the loss $2\ m\ p\ q\ l''\ w''\ d'$ must be multiplied, in order to be equal to the diminished loss caused by the use of lateral reservoirs. Then we have

$$T = m\ l''\ w''\ (d'' - d''' - 2\ a\ p\ q\ d')\ldots(4)$$

Where the condition of a net gain being made by transference from the lower to the upper level is $d'' > (d''' + 2\,a\,p\,q\,d')$.

I am indebted to Mr. Millington of this city for information that a reward of £500 was offered for the invention of a method by which, without any foreign moving force, the loss from lockage in the Regent's canal, London, might be reduced to 0. Such a reduction appears to be impossible in that canal, from the circumstance that the annual average is $d'' < d'''$, and therefore, for a stronger reason, is $d'' < (d''' + 2\,a\,p\,q\,d')$.

The value of the factor a in the canal is $\frac{1}{20}$, and the loss from difference of level is diminished by lateral reservoirs to $\frac{1}{20}$ of that which would otherwise be made.

The formula (4) has been prepared for one lock with two gates, it is obvious that the same holds true of each of the locks of a canal. It is general, and embraces all the varieties of locks.

Make D'' = the annual average of depth of water displaced by descending boat.

D''' = that by ascending boat.

n = the number of passages of boats from summit level to lowest level and back, then, if all the locks are constructed alike,

Make A = the annual amount transferred from one level to the other, positive value upwards.

$$A = m\ n\ l''\ w''\ (D'' - D''' - 2\,a\,p\,q\,d') \ldots\ldots\ldots\ldots (5)$$

Where the condition of positive gain is $D'' > (D''' + 2\,a\,p\,q\,d')$.

The same formula will enable us to determine in any proposed canal where D'' is much greater than D''', the smallest number of locks with which a given difference of level $\triangle$ may be overcome consistent with the above condition, viz. that there shall be an annual gain of water transferred from the lowest to the summit level. In this case

$n\,d' = \triangle$ and $n = \frac{\triangle}{d'}$. Putting $\frac{\triangle}{d'}$ for n in .....(5)

$$A = m\frac{\triangle}{d'} l''\ w''\ (D'' - D''' - 2\,a\,p\,q\,d') \ldots\ldots\ldots (6)$$

From which n disappears and the condition remains as before

$$D'' > (D''' + 2\ a\,p\,q\,d')$$

Transferring D''' to the other side of the inequality, we have

$$(D'' - D''') > 2\,a\,p\,q\,d' \ldots\ldots (7)$$

Dividing this inequality (7)

$$\frac{D'' - D'''}{2\ a\ p\ q} > d' \ldots\ldots\ldots (8)$$

For d' put its value $\frac{\triangle}{n}$

$$\frac{D'' - D'''}{2\ a\ p\ q} > \frac{\triangle}{n} \ldots\ldots\ldots (9)$$

From the inequality (9) it appears that the smallest integer value of n admissible under the above condition, is such that the quotient arising from the division of $\triangle$ by it, must be less than the numerical value of the expression $\frac{D'' - D'''}{2\,a\,p\,q}$; when $a = \frac{1}{20}$ as in the Regent's canal, the inequality (9) becomes

$$\frac{10\ (D'' - D''')}{p\ q} > \frac{\triangle}{n} \ldots\ldots (10)$$

In the Schuylkill we have $D'' > D'''$, because the amount of descending tonnage of anthracite coal far exceeds the amount of ascending tonnage. It is therefore manifest that the condition (8,) or (9,) as well as (10,) is possible in this canal. It is not my object to inquire at present concerning the amount of ascending and descending tonnage, a reference to the statistics of this canal would furnish any one with the means of assigning the value to the first member of these inequalities, and thence to deduce the number of locks required, and the descent of each, subject to the condition that the annual result of lockage on that canal should be a transference of a certain number of tons of water from the tide water of the Schuylkill river to the summit level of the Schuylkill canal.

The above demonstration rests upon the principle of equivalence of action and re-action. In the motion of cars or carriages on roads or railroads, this re-action is not perceptible; the theory of gravitation shows that it exists; let m = the mass transferred on a road; let n = the number of miles on the arc of the earth's circumference through which the car moves; then $m\,n$ = the momentum in this arc of rotation round the earth's axis thus effected by using successive points of this circumference as fixed fulcra; then it is evident that there exists an equivalent motion in the contrary direction of the same arc. This cannot take place among the particles at the earth's surface; accordingly, a motion of the earth's mass takes place, which, resolved in the same arc, is equivalent and contrary. In the motion of boats this re-action takes place immediately and perceptibly by virtue of the same law. If a number of tons of coal be transported on the banks of the Schuylkill canal, an equivalent contrary motion of the earth's mass takes place unperceived; but if the same number of tons of coal be transported in the canal through the same space, then an equal number of tons of water are transferred by re-action through the same space in a contrary direction.

My only aim in the above communication has been to demonstrate a principle first applied to canals by Dr. Dewees, of Pottsville, Pennsylvania, Journal Franklin Institute, vol. xi. p. 111.

Philadelphia, August 21st, 1833.

V

MEMOIRS OF BENJAMIN FRANKLIN:

Compiled for the Mechanics' Magazine.

[For the condensed sketch of the life of this distinguished individual we are indebted chiefly to his own Auto-biography—although we have drawn largely upon an admirable little volume, published in London, under the superintendance of the "Society for the Diffusion of Useful Knowledge," entitled the "Pursuit of Knowledge under Difficulties."—ED. MECH. MAG.]

> Columbia, rising into wealth and power,
> Unites her fame with FRANKLIN'S natal hour.
> FRANKLIN, who struck with awe his country's foes,
> And great before a venal Senate rose.
> Artists, who in your humbler stations stand,
> Earning your bread by Labor's active hand,
> He left the lesson to your useful class—
> Unheeded shall the great example pass?
>
> McCREERY'S TRIBUTE TO THE PRESS.

From my earliest years I had been passionately fond of reading, and I laid out in books all the money I could procure. I was particularly pleased with accounts of voyages. My first acquisition was Bunyan's collection in small separate volumes. These I afterwards sold, in order to buy a historical collection by R. Burton, which consisted of small cheap volumes, amounting in all to about forty or fifty. My father's little library was principally made up of books of practical and polemical theology. I read the greatest part of them. I have since often regretted, that at a time when I had so great a thirst for knowledge, more eligible books had not fallen into my hands, as it was then a point decided that I should not be educated for the church. There was also among my father's books, Plutarch's Lives, in which I read continually, and I still regard as advantageously employed the time I devoted to them. I found, besides, a work of De Foe's, entitled an Essay on Projects, from which, perhaps, I derived impressions that have since influenced some of the principal events of my life.

My inclination for books at last determined my father to make me a printer, though he had already a son in that profession. My brother had returned from England in 1717, with a press and types, in order to establish a printing-house at Boston. This business pleased me much better than that of my father, though I had still a predilection for the sea. To prevent the effects which might result from this inclination, my father was impatient to see me engaged with my brother. I held back for some time; at length, however, I suffered myself to be persuaded, and signed my indentures, being then only twelve years of age. It was agreed that I should serve as an apprentice to the age of twenty-one, and should receive journeyman's wages only during the last year.

In a very short time I made great proficiency in this business, and became very serviceable to my brother. I had now an opportunity of procuring better books. The acquaintance I necessarily formed with booksellers' apprentices, enabled me to borrow a volume now and then, which I never failed to return punctually and without injury. How often has it happened to me to pass the greater part of the night in reading by my bed-side, when the book had been lent me in the evening, and was to be returned the next morning, lest it might be missed or wanted.

At length Mr. Matthew Adams, an ingenious tradesman, who had a handsome collection of books, and who frequented our printing-house, took notice of me. He invited me to see his library, and had the goodness to lend me any books I was desirous of reading. I then took a strange fancy for poetry, and composed several little pieces. My brother, thinking he might find his account in it, encouraged me, and engaged me to write two ballads. One, called the Light-house Tragedy, contained an account of the shipwreck of Captain Worthilake and his two daughters; the other was a sailor's song, on the capture of the noted pirate called *Teach*, or *Black-beard*. They were wretched verses in point of style, mere blindmen's ditties. When printed, he despatched me about town to sell them. The first had a prodigious run, because the event was recent, and had made a great noise.

My vanity was flattered by this success; but my father checked my exultation, by ridiculing my productions, and telling me that versifiers were always poor. I thus escaped the misfortune of being a very wretched poet. But as the faculty of writing prose has been of great service to me in the course of my life, and principally contributed to my advancement, I shall relate by what means, situated as I was, I acquired the small skill I may possess in that way.

When about sixteen years of age, a work of Tryon fell into my hands, in which he recommends vegetable diet. I determined to observe it. My brother being a bachelor did not keep house, but boarded with his apprentices in a neighboring family. My refusing to eat animal food was found inconvenient, and I was often scolded for my singularity. I attended to the mode in which Tryon prepared some of his dishes, particularly how to boil potatoes and rice, and make hasty puddings. I then said to my brother, that, if he would allow me per week half what he paid for my board, I would undertake to maintain myself. The offer was instantly embraced, and I soon found that of what he gave me I was able to save half. This was a new fund for the purchase of books; and other advantages resulted to me from the plan. When my brother and his workmen left the printing-house to go to dinner, I remained behind, and despatching my frugal meal, which frequently consisted of a biscuit only, or a slice of bread and a bunch of raisins, or a bun from the pastry cook's, with a glass of water, I had the rest of the time till their return for study; and my progress therein was proportioned to that clearness of ideas, and quickness of conception, which are the fruit of temperance in eating and drinking.

It was about this period, that, having one day been put to the blush for my ignorance in the art of calculation, which I had twice failed to learn while at school, I took Cocker's Treatise of Arithmetic, and went through it myself with the utmost ease. I also read a book of Navigation, by Seller and Sturmy, and made myself master of the little geometry it contains, but I never proceeded far in this science. Nearly at the same time I read Locke on the Human Understanding, and the Art of Thinking, by Messrs. Du Port Royal.

While laboring to form and improve my style, I met with an English Grammar, which I believe was Greenwood's, having at the end of it two little essays on rhetoric and logic. In the latter I found a model of disputation after the manner of Socrates. Shortly after I procured Xenophon's work, entitled Memorable Things of Socrates, in which are various examples of the same method. Charmed to a degree of enthusiasm with this mode of disputing, I adopted it, and renouncing blunt contradiction, and direct and positive argument, I assumed the character of a humble questioner. The perusal of Shaftsbury and Collins had made me a sceptic; and being previously so as to many doctrines of Christianity, I found Socrates' method to be both the safest for myself, as well as the most embarrassing to those against whom I employed it. It soon afforded me singular pleasure; I incessantly practised it; and became very adroit in obtaining, even from persons of superior understanding, concessions of which they did not foresee the consequences. Thus I involved them in difficulties from which they were unable to extricate themselves, and sometimes obtained victories, which neither my cause nor my arguments merited.

This method I continued to employ for some years; but I afterwards abandoned it by degrees, retaining only the habit of expressing myself with modest diffidence, and never making use, when I advanced any proposition which might be controverted, of the words *certainly*, *undoubtedly*, or any others which might give the appearance of being obstinately attached to my opinion. I rather said, I imagine, I suppose, or it appears to me, that such a thing is so or so, for such and such reasons; or it is so, if I am not mistaken. This habit has, I think, been of considerable advantage to me, when I have had occasion to impress my opinion on the minds of others, and persuade them to the adoption of the measures I have suggested.

In 1720, or 1721, my brother began to print a new public paper. It was the second that made its appearance in America, and was entitled the "New-England Courant." The only one that existed before was the "Boston News Letter." Some of his friends, I remember, would have dissuaded him from this undertaking, as a thing that was not likely to succeed; a single newspaper being, in their opinion, sufficient for all America.

An article inserted in our paper, upon some political subject which I have now forgotten, gave offence to the Assembly. My brother was taken into custody, censured, and ordered into confinement for a month. I was also taken up, and examined before the council; but, though I gave them no satisfaction, they contented themselves with reprimanding, and then dismissing me.

My brother's enlargement was accompanied with an arbitrary order from the House of Assembly, "That James Franklin should no longer print the newspaper entitled the 'New-England Courant.'" In this conjuncture we held a consultation of our friends at the printing-house, in order to determine what was to be done. Some proposed to evade the order, by changing the title of the paper; but my brother thought it better that it should in future be printed in the name of Benjamin Franklin; and it was resolved that my old indentures should be given up to me with a full and entire discharge written on the back.

Some time afterwards a new difference arising between my brother and me, I ventured to take advantage of my liberty, presuming that he would not dare to produce the new contract. It was undoubtedly dishonorable to avail myself of this circumstance, and I reckon this action as one of the first errors of my life.

These differences with my brother still continuing, I determined on going to New-York, the nearest town in which there was a printing-house. My friend Collins undertook to favor my flight. He agreed for my passage with a captain of a New-York sloop, to whom he represented me as a young man of his acquaintance, who had an affair with a girl of bad character, whose parents wished to compel me to marry her. I sold part of my books to procure a small sum of money, and went privately on board the sloop. By favor of a good wind, I found myself in three days at New-York, nearly three hundred miles from my home, at the age only of seventeen years, without knowing an individual in the place, and with very little money in my pocket.

From thence, after a stay of two or three days, I went to Philadelphia, where I arrived in my working dress, my best clothes being to come by sea. I was covered with dirt; my pockets were filled with shirts and stockings; I was unacquainted with a single soul in the place, and knew not where to look for a lodging. Fatigued with walking, rowing, and having passed the night without sleep, I was extremely hungry, and all my money consisted of a Dutch dollar, and about a shilling's worth of coppers, which I gave to the boatmen for my passage. As I had assisted them in rowing, they refused it at first; but I insisted on their taking it. In this manner I went

through Market street to Fourth street, and passed the house of Mr. Read, the father of my future wife. She was standing at the door, observed me, and thought with reason that I made a very singular and grotesque appearance.

In Philadelphia there were but two printers, and they appeared destitute of every qualification necessary in their profession. Bradford had not been brought up to it, and was very illiterate. Keimer, though he understood a little of the business, was merely a compositor, and wholly incapable of working at press. With him I obtained employ. One day, Keimer and I being at work together near the window, we saw the Governor and another gentleman, Colonel French, of Newcastle, handsomely dressed, cross the street, and make directly for our house. We heard them at the door, and Keimer, believing it to be a visit to himself, went immediately down; but the Governor inquired for me, came up stairs, and with a condescension and politeness to which I had not at all been accustomed, paid me many compliments, desired to be acquainted with me, obligingly reproached me for not having made myself known to him on my arrival in the town, and wished me to accompany him to a tavern, where he and Colonel French were going to taste some excellent Madeira wine.

I was, I confess, somewhat surprized, and Keimer appeared thunderstruck. I went, however, with the Governor and the Colonel to a tavern at the corner of Third street, where, while we were drinking the Madeira, he proposed to me to establish a printing-house. He set forth the probabilities of success, and himself and Colonel French assured me that I should have their protection and influence in obtaining the printing of the public papers of both governments; and as I appeared to doubt whether my father would assist me in this enterprize, Sir William said he would give me a letter to him, in which he would represent the advantages of the scheme, in a light which he had no doubt would determine him. It was thus concluded that I should return to Boston by the first vessel, with the letter of recommendation from the Governor to my father. Meanwhile the project was to be kept secret, and I continued to work for Keimer as before.

Towards the end of April, 1724, a small vessel was ready to sail for Boston. I took leave of Keimer upon the pretext of going to see my parents. We arrived at Boston after about a fortnight's passage.

The Governor's letter appeared to excite in my father some surprize; and though he could not approve Sir William's proposal, was yet pleased that I had obtained so advantageous a recommendation as that of a person of his rank, and that my industry and economy had enabled me to equip myself so handsomely in so short a period.

On my arrival in Philadelphia I delivered my father's letter to Sir William: he thought him too prudent. There was a difference, he said, between individuals: years of maturity were not always accompanied with discretion, neither was youth in every instance devoid of it. "Since your father," added he, "will not set you up in business, I will do it myself. Make out a list of what will be wanted from England, and I will send for the articles. You may repay me when you can. I am determined to have a good printer here, and I am sure you will succeed."

I gave him the inventory of a small printing-office; the expense of which I had calculated at about a hundred pounds sterling. He expressed his approbation; but asked, if my presence in England, that I might choose the characters myself, and see that every article was good in its kind, would not be an advantage? "You will also be able," said he, "to form some acquaintance there, and establish a correspondence with stationers and booksellers." This I acknowledged was desirable. "That being the case," added he, "hold yourself in readiness to go with the Annis." This was the annual vessel, and the only one at that time, which made regular voyages between the ports of London and Philadelphia.

The company in the cabin were all very sociable, and we were perfectly well off as to provisions.

On delivering my letters, I was astonished at finding these letters were not from the Governor. Reflecting, and putting circumstances together, I then began to doubt his sincerity. I rejoined my friend Denham, and related the whole affair to him. He let me at once into Keith's character, told me there was not the least probability of his having written a single letter; that no one who knew him ever placed any reliance on him, and laughed at my credulity in supposing that the Governor would give me a letter of credit, when he had no credit for himself.

I immediately got engaged at Palmer's, at that time a noted printer in Bartholomew-close, with whom I continued nearly a year. I applied very assiduously to my work.

I had brought some curiosities with me from America; the principal of which was a purse made of the asbestos, which fire only purifies. Sir Hans Sloane hearing of it, called upon me, and invited me to his house in Bloomsbury square, where, after showing me every thing that was curious, he prevailed on me to add this piece to his collection; for which he paid me very handsomely.

I now began to think of laying by some money. The printing-house of Watts, near Lincoln's-inn fields, being a still more considerable one than that in which I worked, it was probable I might find it more advantageous to be employed there. I offered myself, and was accepted; and in this house I continued during the remainder of my stay in London.

I drank nothing but water. The other work-

men, to the number of about fifty, were great drinkers of beer. I carried, occasionally, a large form of letters in each hand, up and down stairs, while the rest employed both hands to carry one. They were surprized to see, by this, and many other examples, that the *American Aquatic*, as they used to call me, was stronger than those who drank porter.

London began to tire me; the agreeable hours I had passed at Philadelphia presented themselves to my mind, and I wished to see them revive. I consequently engaged myself to Mr. Denham, a merchant about sailing for America, at a salary of fifty pounds a year. This was indeed less than I earned as a compositor, but then I had a much fairer prospect. I took leave, therefore, as I believed for ever, of printing, and gave myself up to my new occupation.

We sailed from Gravesend on the 23d of July, 1726. For the incidents of my voyage I refer you to my Journal, where you will find all its circumstances minutely related. We landed at Philadelphia on the 11th of the following October.

Mr. Denham was taken ill, I have forgotten what was his disorder; but it was a tedious one, and he at last sunk under it. He left me a small legacy in his will, as a testimony of his friendship; and I was once more abandoned to myself in the wide world.

[Thus far we have abridged and condensed the life of this distinguished man, written by himself; the rest has been collected from various sources.]

He now engaged again with his old master, Keimer, the printer, who had got a better house, and plenty of new types, though he was still as ignorant of his business as he was at the time of Franklin's former connection with him. He showed his ingenuity, and the fertility of his resources, on various occasions. They wanted some new types, which, there being no letter-foundry in America, were only to be procured from England; but Franklin, having seen types cast in London, though he had paid no particular attention to the process, contrived a mould, made use of the letters they had as puncheons, struck the matrices in lead, and thus supplied, as he tells us, in a pretty tolerable way, all deficiences.

He did not, however, remain long with Keimer, but entered into an agreement with one of his fellow-workmen, of the name of Meredith, whose friends were possessed of money, to begin business in Philadelphia in company with him, the understanding being that Franklin's skill should be placed against the capital to be supplied by Meredith.

Shortly after this arrangement was completed the types that had been sent for from London arrived; and he and his partner took a house and commenced business. "We had scarce opened our letters," says he, "and put our press in order, before George House, an acquaintance of mine, brought a countryman to us, whom he had met in the street, inquiring for a printer. All our cash was now expended in the variety of particulars we had been obliged to procure, and this countryman's five shillings, being our first fruits, and coming so seasonably, gave me more pleasure than any crown I have since earned; and, from the gratitude I felt towards House, has made me often more ready than perhaps I otherwise should have been, to assist young beginners." He had, in the autumn of the preceding year, suggested to a number of his acquaintances a scheme for forming themselves into a club for mutual improvement; and they had accordingly been in the habit of meeting every Friday evening under the name of the Junto. All the members of this association exerted themselves in procuring business for him; and one of them, named Breinthal, obtained from the Quakers the printing of forty sheets of a history of that sect of religionists, then preparing at the expense of the body. "Upon these," says Franklin, "we worked exceeding hard, for the price was low. It was a folio. I composed a sheet a day, and Meredith worked it off at press. It was often eleven at night, and sometimes later, before I had finished my distribution for the next day's work; for the little jobs sent in by our other friends, now and then, put us back. But so determined was I to continue doing a sheet a day of the folio, that one night, when, having imposed my forms, I thought my day's work over, one of them by accident was broken, and two pages, the half of the day's work, reduced to *pie;* I immediately distributed and composed it over again before I went to bed; and this industry, visible to our neighbors, began to give us character and credit." The consequence was that business, and even offers of credit, came to them from all hands.

They soon found themselves in a condition to think of establishing a newspaper; but Franklin having inadvertently mentioned this scheme to a person who came to him wanting employment, that individual carried the secret to their old master, Keimer, with whom he, as well as themselves, had formerly worked, and he immediately determined to anticipate them by issuing proposals for a paper of his own. The manner in which Franklin met and defeated this treachery is exceedingly characteristic. There was another paper published in the place, which had been in existence for some years; but it was altogether a wretched affair, and owed what success it had merely to the absence of all competition. For this print, however, Franklin, not being able to commence his own paper immediately, in conjunction with a friend, set about writing a series of amusing communications under the title of the Busy Body, which the publisher printed, of course, very gladly. "By this means," says he, "the attention of the public was fixed on that paper;

and Keimer's proposals, which we burlesqued and ridiculed, were disregarded. He began his paper, however; and before carrying it on three-quarters of a year, with at most only ninety subscribers, he offered it me for a trifle; and I, having been ready some time to go on with it, took it in hand directly, and it proved in a few years extremely profitable to me." The paper, indeed, had no sooner got into Franklin's hands, than its success equalled his most sanguine expectations. Some observations which he wrote and printed in it on a colonial subject, then much talked of, excited so much attention among the leading people of the place, that it obtained the proprietors many friends in the House of Assembly, and they were, on the first opportunity, appointed printers to the house. Fortunately, too, certain events occurred about this time which ended in the dissolution of Franklin's connection with Meredith, who was an idle, drunken fellow, and had all along been a mere incumbrance upon the concern. Thus, about the year 1729, when he was yet only in the twenty-fourth year of his age, he found himself, after all his disappointments and vicissitudes, with nothing, indeed, to depend upon but his own skill and industry for gaining a livelihood, and for extricating himself from debt, but yet in one sense fairly established for life, and with at least a prospect of well-doing before him.

Having followed his course thus far with so minute an observance of the several steps by which he arrived at the point to which we have now brought him, we shall not attempt to pursue the remainder of his career with the same particularity. His subsequent efforts in the pursuit of fortune and independence were, as is well known, eminently successful; and we find in his whole history, even to its close, a display of the same spirit of intelligence and love of knowledge, and the same active, self-denying, and intrepid virtues, which so greatly distinguished its commencement. In 1732 he first published his celebrated almanac, under the name of *Richard Saunders*, but which was commonly known by the name of Poor Richard's Almanac. He continued this publication annually for twenty-five years. The proverbs and pithy sentences scattered up and down in the different numbers of it, were afterwards thrown together into a connected discourse under the title of *The Way to Wealth*, a production which has become so extensively popular, that every one of our readers is probably familiar with it.

In 1736 he was chosen clerk of the General Assembly, and being soon after appointed deputy post-master for the State, he turned his thoughts to public affairs.

It is time, however, that we should introduce this extraordinary man to our readers in a new character. A much more important part in civil affairs than any he had yet acted was in reserve for him. He lived to attract to himself, on the theatre of politics, the eyes, not of his own countrymen only, but of the whole civilized world; and to be a principal agent in the production of events as mighty in themselves, and as pregnant with mighty consequences, as any belonging to modern history. But our immediate object is to exhibit a portrait of the diligent student, and of the acute and patient philosopher. We have now to speak of Franklin's famous electrical discoveries. Of these discoveries, we cannot, of course, here attempt to give any thing more than a very general account. But we shall endeavor to make our statement as intelligible as possible, even to those to whom the subject is new; referring them, for more particular information in regard to it, to the treatise on Electricity in the Library of Useful Knowledge, and the other works in which the principles of the science are formally expounded.

The term electricity is derived from *electron*, the Greek name for amber, which was known, even in ancient times, to be capable of acquiring, by being rubbed, the curious property of attracting very light bodies, such as small bits of paper, when brought near to them. This virtue was thought to be peculiar to the substance in question, and one or two others, down to the close of the sixteenth century, when our ingenious and philosophic countryman, William Gilbert, a physician of London, announced for the first time, in his Latin treatise on the magnet, that it belonged equally to the diamond and other precious stones; to glass, sulphur, sealing wax, rosin, and a variety of other substances. It is from this period that we are to date the birth of the science of Electricity, which, however, continued in its infancy for above a century, and could hardly, indeed, be said to consist of any thing more than a collection of unsystematized and ill understood facts, until it attracted the attention of Franklin.

It was in the year 1746, as he tells us himself in the narrative of his life, that, being at Boston, he met with a Dr. Spence, who had lately arrived from Scotland, and who showed him some electrical experiments. They were imperfectly performed, as the doctor was not very expert; "but being," says Franklin, "on a subject quite new to me, they equally surprized and pleased me. Soon after my return to Philadelphia, our Library Company received from Mr. Peter Collinson, F. R. S. of London, a present of a glass tube, with some account of the use of it in making such experiments. I eagerly seized the opportunity of repeating what I had seen at Boston; and, by much practice, acquired great readiness in performing those also which we had an account of from England, adding a number of new ones. I say much practice, for my house was continually full for some time, with persons who came to see these new wonders. To divide a little this incumbrance among my friends, I caused a

number of similar tubes to be blown in our glass-house, with which they furnished themselves, so that we had at length several performers." The newly discovered and extraordinary phenomenon exhibited by the Leyden phial, of course very early engaged his attention in pursuing these interesting experiments; and his inquisitive mind immediately set itself to work to find out the reason of such strange effects, which still astonished and perplexed the ablest philosophers of Europe. Out of his speculations arose the ingenious and beautiful theory of the action of the electric influence, which is known by his name; and which has ever since been received by the greatest number of philosophers as the best, because the simplest and most complete demonstration of the phenomena, that has yet been given to the world.

Franklin did not rest contented with ascertaining the principle of the Leyden phial. He made also a very happy application of this principle, which afforded a still more wonderful manifestation than had yet been obtained of the powers of accumulated electricity. Considering the waste that took place, in the common experiment, of the fluid expelled, during the process of charging, from the exterior coating, he conceived the idea of employing it to charge the inner surface of a second jar, which he effected, of course, by the simple expedient of drawing it off by means of a metal rod communicating with that surface. The electricity expelled from the outside of this second jar was conveyed, in like manner, into the inside of a third; and, in this way, a great number of jars were charged with the same facility as a single one. Then, having connected all the inside coatings with one conductor, and all the outside coatings with another, he had merely to bring these two general conductors into contact or communication, in order to discharge the whole accumulation at once. This contrivance he called an *Electrical Battery.*

We now turn to a very brilliant discovery of this illustrious philosopher, the reality of which does not depend upon the truth or falsehood of any theory.

Franklin was by no means the first person to whom the idea had suggested itself of a similarity between electricity and lightning. Not to mention many other names which might be quoted, the Abbe Nollet had, before him, not only intimated his suspicion that thunder might be in the hands of Nature what electricity is in ours, but stated a variety of reasons on which he rested his conjecture. It is to Franklin alone, however, that the glory belongs of both pointing out the true method of verifying this conjecture, and of actually establishing the perfect identity of the two powers in question. "It has, indeed, been of late the fashion," says the editor of the first account of his electrical experiments, published at London in 1751, "to ascribe every grand or unusual operation of nature, such as lightning and earthquake, to electricity; not, as one would imagine from the manner of reasoning on these occasions, that the authors of these schemes have discovered any connexion between the cause and effect, or saw in what manner they were related; but, as it would seem, merely because they were unacquainted with any other agent, of which it could not positively be said the connection was impossible." Franklin transformed what had been little more than a figure of rhetoric into a most important scientific fact.

In a paper, dated November 7, 1749, he enumerates all the known points of resemblance between lightning and electricity. In the first place, he remarks, it is no wonder that the effects of the one should be so much greater than those of the other; for if two gun-barrels electrified will strike at two inches distance, and make a loud report, at how great a distance will ten thousand acres of electrified cloud strike, and give its fire; and how loud must be that crack! He then notices the crooked and waving course, both of the flash of lightning, and, in some cases, of the electric sparks; the tendency of lightning, like electricity, to take the readiest and best conductor; the facts that lightning, as well as electricity, dissolves metals, burns some bodies, rends others, strikes people blind, destroys animal life, reverses the poles of magnets, &c.

He had known for some time the extraordinary power of pointed bodies, both in drawing and in throwing off the electric fire. The true explanation of this fact did not occur to him: but it is a direct consequence of the fundamental principle of his own theory, according to which the repulsive tendency of the particles of electricity towards each other, occasioning the fluid to retire, in every case, from the interior to the surface of bodies, drives it with especial force towards points and other prominences, and thus favors its escape through such outlets; while, on the other hand, the more concentrated attraction which the matter of a pointed body, as compared with that of a blunt one, exerts upon the electricity to which it is presented, brings it down into its new channel in a denser stream. In possession, however, of the fact, we find him concluding the paper we have mentioned as follows: "The electric fluid is attracted by points. We do not know whether this property be in lightning; but since they agree in all the particulars in which we can already compare them, it is not improbable that they agree likewise in this. Let the experiment be made."

Full of this idea, it was yet some time before he found what he conceived a favorable opportunity of trying its truth in the way he meditated. A spire was about to be erected in Philadelphia, which he thought would afford him facilities for the experiment; but his attention having been one day drawn by a kite which a boy was flying, it suddenly occurred to him that

here was a method of reaching the clouds preferable to any other. Accordingly, he immediately took a large silk handkerchief, and stretching it over two cross sticks, formed in this manner his simple apparatus for drawing down the lightning from its cloud. Soon after, seeing a thunder-storm approaching, he took a walk into a field in the neighborhood of the city, in which there was a shed, communicating his intentions, however, to no one but his son, whom he took with him, to assist him in raising the kite; this was in June, 1752.

The kite being raised, he fastened a key to the lower extremity of the hempen string, and then insulated it by attaching it to a post by means of silk, he placed himself under the shed and waited the result. For some time no signs of electricity appeared. A cloud, apparently charged with lightning, had even passed over them without producing any effect. At length, however, just as Franklin was beginning to despair, he observed some loose threads of the hempen string rise and stand erect, exactly as if they had been repelled from each other by being charged with electricity. He immediately presented his knuckle to the key, and to his inexpressible delight drew from it the well known electrical spark. It is said that his emotion was so great at this completion of a discovery which was to make his name immortal, that he heaved a deep sigh, and felt that he could that moment have willingly died. As the rain increased the cord became a better conductor, and the key gave out its electricity copiously. Had the hemp been thoroughly wet, the bold experimenter might, as he was contented to do, have paid for his discovery with his life.

He afterwards brought down the lightning into his house by means of an insulated iron rod, and performed with it, at his leisure, all the experiments that could be performed with electricity. But he did not stop here. His active and practical mind was not satisfied even with the splendid discovery, until he had turned it to a useful end. It suggested to him, as is well known, the idea of a method of preserving buildings from lightning, which is extremely simple and cheap, as well as effectual; consisting, as it does, in nothing more than attaching to the building a pointed metallic rod, rising higher than any part of it, and communicating at the lower end with the ground. This rod the lightning is sure to seize upon in preference to any part of the building; by which means it is conducted to the earth, and prevented from doing any injury. There was always a strong tendency in Franklin's philosophy to these practical applications. The lightning rod was probably the result of some of the amusing experiments with which Franklin was, at the commencement of his electrical investigations, accustomed to employ his own leisure, and afford pleasure to his friends. In one of his letters to Mr. Collinson, dated so early as 1748, we find him expressing himself in the following strain, in reference to his electrical experiments: "Chagrined a little that we have hitherto been able to produce nothing in this way of use to mankind, and the hot weather coming on, when electrical experiments are not so agreeable, it is proposed to put an end to them for this season somewhat humorously, in a party of pleasure on the banks of *Skuylkill*. Spirits at the same time are to be fired by a spark, sent from side to side through the river, without any other conductor than the water—an experiment which we have some time since performed to the amazement of many. A turkey is to be killed for dinner by the *electrical shock*, and roasted by the *electrical jack*, before a fire kindled by the *electrified bottle;* when the healths of all the famous electricians in *England*, *Holland*, *France*, and *Germany*, are to be drunk in *electrified bumpers*, under the discharge of guns from the *electrical battery*."

Franklin's electrical discoveries did not, on their first announcement, attract much attention in England; and, indeed, he had the mortification of learning that his paper on the similarity of lightning to electricity, when read by a friend to the Royal Society, had been only laughed at by that learned body. In France, however, the account that had been published in London of his experiments, fortunately fell into the hands of the celebrated naturalist, Buffon, who was so much struck with it, that he had it translated into French, and printed at Paris. This made it immediately known to all Europe, and versions of it in various other modern languages soon appeared, as well as one in Latin. The theory propounded in it was first violently opposed in France by the Abbe Nollet, who had one of his own to support, and, as Franklin tells us, could not at first believe that such a work came from America, but said it must have been fabricated by his enemies at Paris. The Abbe was eventually, however, deserted by all his partisans, and lived to see himself the last of his sect. In England, too, the Franklinian experiments gradually began to be more spoken of; and at last, even the Royal Society was induced to resume the consideration of the papers that had formerly been read to them. One of their members verified the grand experiment of bringing down lightning from the clouds; and upon his reading to them an account of his success, "they soon," says Franklin, "made me more than amends for the slight with which they had before treated me. Without my having made any application for that honor, they chose me a member; and voted that I should be excused the customary payments, which would have amounted to twenty-five guineas; and ever since have given me their Transactions gratis. They also presented me with the gold medal of Sir Godfrey Copley, for the year 1753, the delivery of which was ac-

companied with a very handsome speech of the President, Lord Macclesfield, wherein I was highly honored." Some years afterwards, when he was in this country with his son, the University of St. Andrew's conferred upon him the degree of Doctor of Laws; and its example was followed by the Universities of Edinburgh and Oxford. He was also elected a member of many of the learned societies throughout Europe.

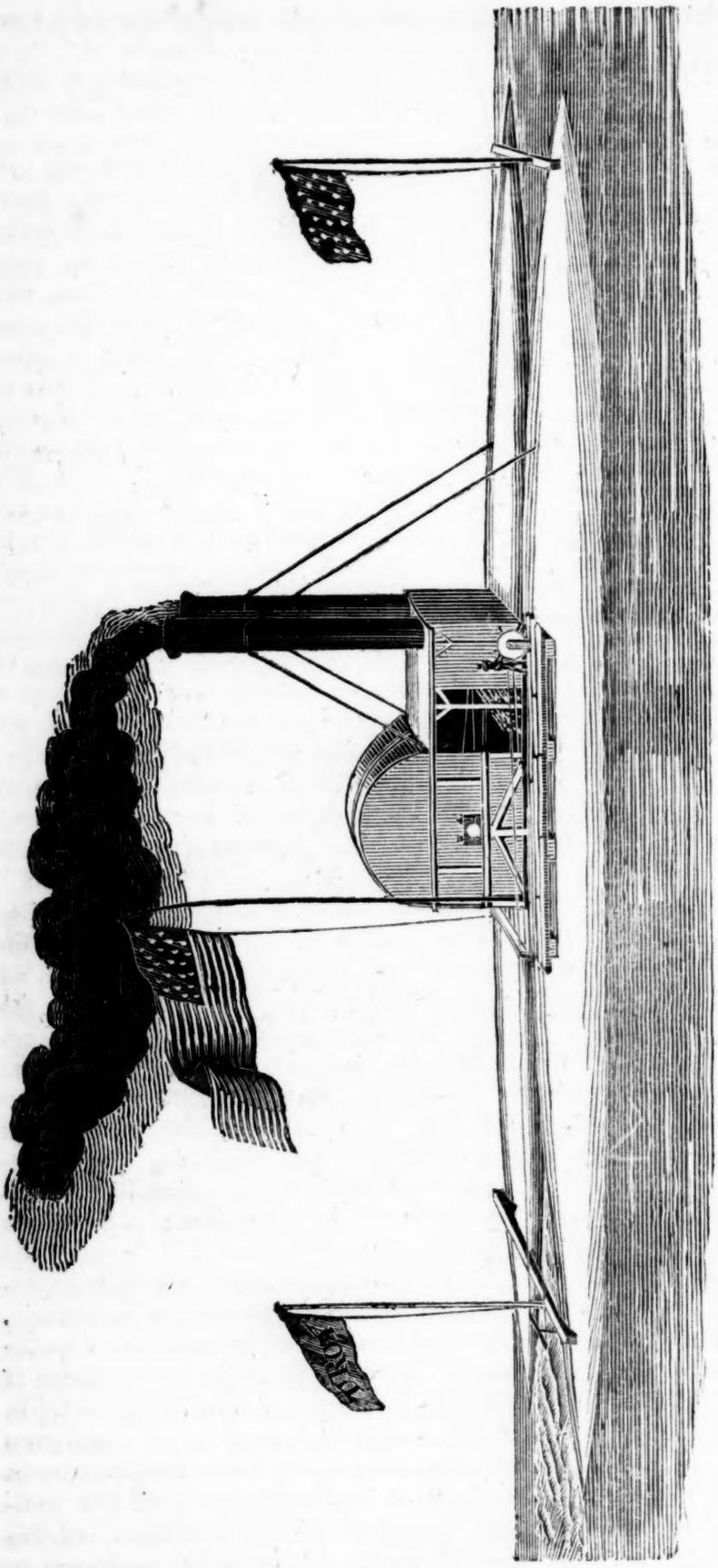
No philosopher of the age now stood on a prouder eminence than this extraordinary man, who had originally been one of the most obscure of the people, and had raised himself to all this distinction almost without the aid of any education but such as he had given himself. Who will say, after reading his story, that any thing more is necessary for the attainment of knowledge than the determination to attain it? that there is any other obstacle to even the highest degree of intellectual advancement which may not be overcome, except a man's own listlessness or indolence? The secret of this man's success in the cultivation of his mental powers was, that he was ever awake and active in that business; that he suffered no opportunity of forwarding it to escape him unimproved; that, however poor, he found at least a few pence, were it even by diminishing his scanty meals, to pay for the loan of the books he could not buy; that, however hard-wrought, he found a few hours in the week, were it by sitting up half the night, after toiling all the day, to read and study them. Others may not have his original powers of mind; but his industry, his perseverance, his self-command, are for the imitation of all: and though few may look forward to the rare fortune of achieving discoveries like his, all may derive both instruction and encouragement from his example. They who may never overtake the light, may at least follow its path, and guide their footsteps by its illumination.

Were we to pursue the remainder of Franklin's history, we should find the fame of the patriot vying with that of the philosopher, in casting a splendor over it; and the originally poor and unknown tradesman standing before kings, associating as an equal with the most eminent statesmen of his time, and arranging along with them the wars and treaties of mighty nations. When the struggle of American independence commenced, he was sent as ambassador from the United States to the Court of France, where he soon brought about an alliance between the two countries, which produced an immediate war between the latter and England. In 1783, he signed, on the part of the United States, the treaty of peace with England, which recognized their independence. Two years after, he returned to his native country, where he was received with acclamation by his grateful and admiring fellow-citizens, and immediately elected President of the Supreme Executive Council. He closed his eventful and honorable life on the 17th of April, 1790, in the eighty-fifth year of his age.

For anecdotes of B. Franklin, see page 263 of Vol. I., and pages 39, 96, 166, 187, of Vol. II.

The New Era of Steam Power.—In our first volume, at page 118, we inserted a short article on the probable application of steam power to various purposes during the year, which is now nearly brought to a close. We there state that "every day brings to light some new form in which its irresistible energies may be employed. Ten years ago the idea of substituting a steam engine for a horse, as propelling power on a turnpike road, would have been thought chimerical. * * * We shall not be surprized to find it, before the year is out, employed to extinguish fires, to blast rocks, or in excavating the earth for canals. No man can set bounds to its utility, or the modes of its application." Since then we have received various reports of the success of steam carriages on common roads, and as a proof of their being in practical operation, we refer our readers to page 311 of this Magazine, where will be found an account, (taken from the London Repertory of Arts for November,) of their performance on one of the most crowded roads in the vicinity of that metropolis; it has also been used in extinguishing fires, as will be seen by reference to page 329. Inventions and suggestions of importance, as connected with steam power, have within the last few weeks so multiplied upon us that we have resolved to give, in as condensed a form as possible, all the information we have received in this article, and as one of the most important, we shall commence with an account of Mr. Burden's new steamboat, an invention which we hesitate not to say is of the first importance.

On the 13th of December, we made an excursion up the North river as far as Yonkers, between twenty and twenty-one miles from the foot of Courtland street, on the foundation of it as represented in the drawing annexed. In its passage out, in consequence of some parts of the machinery being disarranged, no attempt was made to obtain a greater speed than ordinary steamboats. When at Yonkers, all was ready to put the principle of the movement to the test, and the result was, that in one hour and one minute we arrived at Courtland street.



Our esteemed correspondent, MR. BLYDENBURGH, of Lansingburgh, who has had frequent opportunity of witnessing the construction of it, has forwarded a description of its formation. This description has been submitted to Mr. Burden, who, after making some trivial alterations, has stated that he has no objection that it should be made public—*that he considers it a correct one:* it is, therefore, subjoined. It is evident that it is capable of performing all that its inventor has promised, and its importance to navigation cannot but be obvious to every one. Mr. Blydenburgh thus writes:

The principle on which the invention is founded consists in placing two hollow parabolic spindles parallel to each other, at sufficient distance to admit a wheel between them, and by connecting them together by strong timbers across the top, both before and aft the wheel, in such manner as not only to give the necessary strength, but also to serve as a foundation whereon to erect the necessary superstructure both for the machinery and for the accommodation of passengers. In his present boat the spindles or trunks are 300 feet long, and 8 feet diameter in the centre, tapering in a regular parabolic curve, to a point at each end. They are placed, as above stated, parallel to each other, and I believe 16 feet inside apart in the clear. The wheel between them is about 30 feet diameter, and 15 feet in length. The buckets are so arranged, as to number and situation, as to prevent the jolting motion felt in the other boats as the buckets strike the water.

To ascertain the buoyancy of this boat, or the burthen she will carry, I take the common method to measure a parabolic spindle—thus: $8\times8\times.7854=50.2656$ superficial contents at

centre; $300\times8\div15\times50\cdot2656=8042\cdot4960$ cubic feet, solid contents, say 8042·5 cubic feet, $\times62$ =49863·5 pounds weight of water displaced by each spindle, equal to 222 tons 12 cwt. Then the two spindles will require 222½ tons, including their own weight, to sink them to their centre; in which case they would only draw 4 feet of water. Allow, then, the boat and machinery to weigh 70 tons, which I think is not below the truth, and allow 500 passengers to weigh 37½ tons, then the boat, machinery, and passengers will weigh 107½, and will require 115* tons more to make it draw 4 feet of water.

If the above calculations be true, and they cannot be far out of the way, the boat, with any reasonable load, will never draw 4 feet, and seldom so much.

With respect to her speed, the time and room will not admit of mathematical calculations, though they could easily be made; and Mr. B., who appears to me to be a man of scientific as well as practical knowledge, has doubtless made them; but I am confident, from her great length, narrow breadth, and light draught, she will equal in her motion the most sanguine expectations. I am confident, that with a little practice to get her waywise, she will make the trip to New-York, a distance of 160 miles, and back, allowing a reasonable stop there, not only by sunshine, but an easy day's work.

It has been said she cannot live in rough water. On this point, I have no hesitation in saying that the same weight of materials could not be combined to form a vessel in any other shape with greater, if with equal strength; and one peculiar advantage it possesses over any other steamboat in rough water is, that her whole weight is borne on the outside of her width, while that of other steamboats is in a narrow compass in the middle: while, therefore, the common boat in a rolling sea is liable to overset, or displace her machinery by rolling, and will almost constantly have one wheel out of water, Mr. B.'s boat, standing upon a broad foundation, can roll but little, and the wheel, by being in the middle, will of course maintain an even depth in the water, and the swell not consequently interrupt her speed.

On the whole, from the opinion I entertain of the talents of Mr. Burden, and from what I have seen of his boat, if the invention does not mark a new era in the history of locomotion, as respects rapid and safe travelling, I will willingly submit to be branded as a false prophet.

Our readers will have observed that the construction of this boat is on a principle that can scarcely be misunderstood by any one. Every person knows that a mass moves more easily through the water endwise than sidewise; and as the editor of the Journal of Commerce very justly observes, "Mr. Burden has carried the principle to its *ne plus*; instead of building a boat so narrow that she could hardly be made to stand erect, he has made a *pair* of boats, and so being relieved from all danger of capsizing, he has been able to elongate them to his heart's content." The rudder, which is placed immediately behind the flag with the word TROY on it, is only a plate of iron about 6 feet long, and about 5 inches wide, and is governed by the motion of a steering wheel, placed parallel with the boiler, on the same trunk to which it is connected by ropes, as will be seen in the engraving: it is similar to a common steering wheel, and as the chief weight of the parabolic spindles or trunks is in the centre, it causes it to revolve as on a pivot. This may be illustrated by placing a common rolling pin used in making pastry, of the same form, on a table, and turning it; that will form a complete circle, and on that principle, this boat turns, whereas all other vessels turn on their stern.

Fig. 2.

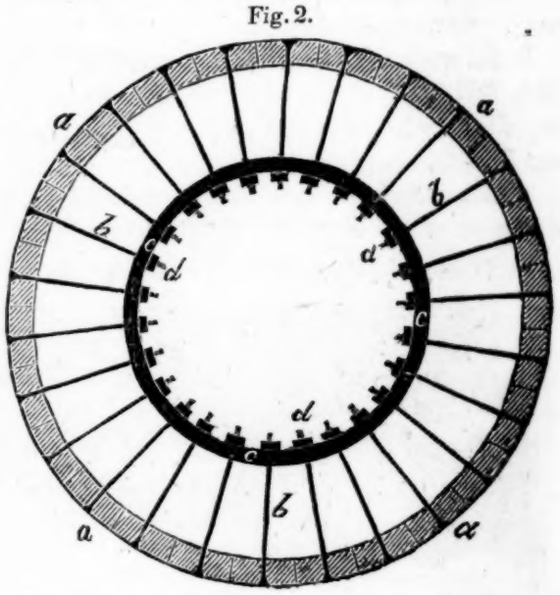
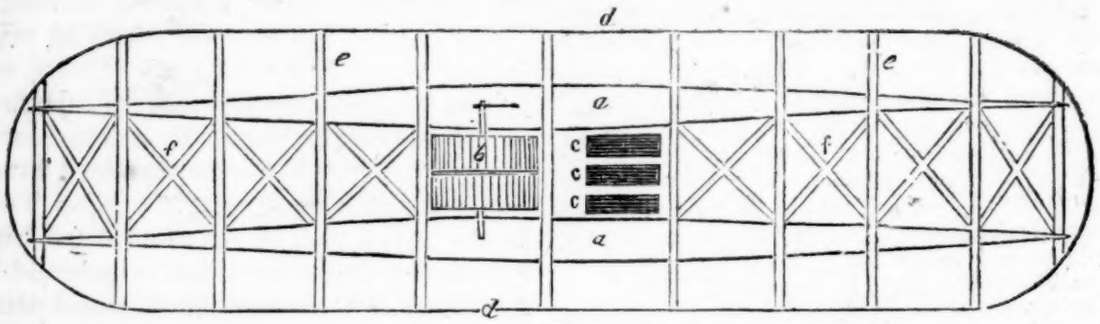


Fig. 2 is a cross section of the internal part of one of the trunks: *a a a a*, the staves, 26 in number, 3½ inches thick, to each of which is attached an iron bolt, *b b b*, 26 inches in length, passing through the staves, and countersunk on the outside of them: these bolts are fastened to an iron ring, *c*, by means of nuts, *d d d*, screwed on the inside; so that the tighter the nut is screwed, the more compact it makes those staves immediately opposite. Sufficient room is left in the centre for a man to enter and pass fore and aft, to turn the nuts, if necessary.

Fig. 3 shows the plan of connecting these

* Mr. Burden states that from 180 to 200 tons burthen will occasion a draught of 4 feet.

Fig. 3.



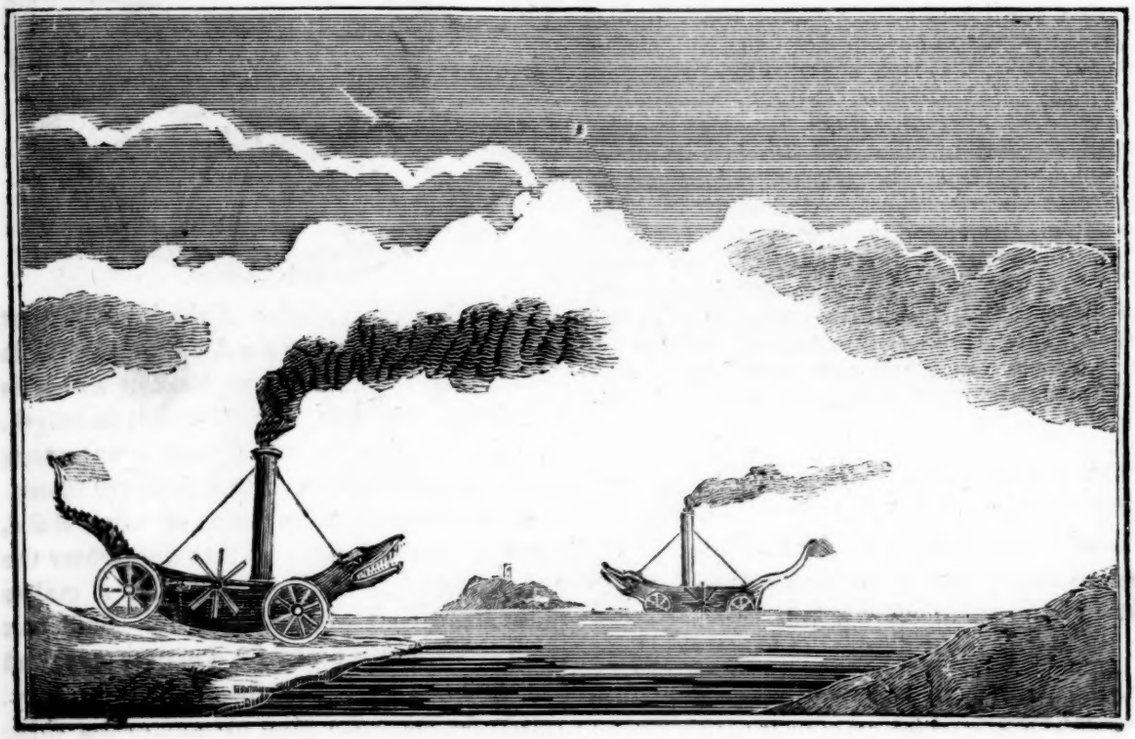
two spindles or trunks, upon which the decks are to be built. *a a*, the trunks or spindles; *b*, the water wheel; *c c c*, the boilers; *e e*, the beams which connect it with the outside guard *d*; *f f*, the braces.

We think it right to state another fact in connection with the advantages which we have enumerated; and that is in her complete exemption from jarring or vibration while under way. The passengers in this boat could easily imagine themselves upon terra firma, were it not for her great velocity.

It is, we understand, to be named the EMMA, OF TROY, in respect, on the part of the inventor, to his amiable and intelligent partner for life.

The boilers have been constructed under the direction of the Rev. Dr. Nott, who accompanied us on our trip, a man distinguished by his piety and scientific attainments; and we have the authority of the editor of the N. Y. Gazette, for stating that "Dr. Nott stated that he would have no hesitation in placing his cot over the boiler, at all times, and going to sleep with perfect composure, without any dread of danger; and that it was among his happiest reflections, that he had lived long enough to have contributed so much towards the preservation of human life, while so many thousands were enjoying the benefit of steam navigation."

We shall now introduce a plan of a machine calculated to go by land and water, propelled by steam, for the design of which we are indebted to the "Young Mechanic." Its construction is so simple that we consider a description unnecessary. In those districts where ferries are frequently to be crossed, we think it might be advantageously used.



Hitherto the chief obstacle of going long voyages by sea in steamboats, has been the difficulty of carrying sufficient fuel. That obstacle is in a great measure obviated by a discovery of Mr. Rutter, an engineer in England, for generating heat by water, to which we have before alluded at pages 117 and 182, and which we think still we shall be able to prove was first discovered by an American citizen. At present, we shall copy Mr. Rutter's account from the London Mechanics' Magazine.

"My invention of an improved process for generating heat, applicable to the heating of boilers and retorts, and to other purposes for which heat is required, consists in the employment of bituminous, oleaginous, resinous, waxy, or fatty substances, in a liquid state, and in conjunction with water as fuel, in manner hereinafter described. I carry my said improved process into effect in manner following, that is to say, by allowing or causing one or more of the said bituminous, oleaginous, resinous, waxy, or fatty substances, as coal tar, for instance, to flow from a cistern or other vessel suitably placed, through a pipe or other convenient channel, into a spout or funnel communicating with the interior of an enclosed fire-place or furnace, and at the same time allowing or causing water to flow from a cistern or vessel, placed in a suitable or convenient situation, through another pipe, or other convenient channel, into the beforementioned spout or funnel, in which spout or funnel they are allowed or caused to flow or drop simultaneously upon a fire previously kindled and burning within the before-mentioned inclosed fire-place or furnace, subject to the regulations hereinafter mentioned or described. It is not essential that the coal tar, or other of the before-mentioned substances, should first come into contact with the water in the spout which communicates with the interior of the enclosed fire-place or furnace. Indeed, I rather prefer that they should first come in contact with each other in a funnel at some little distance from the furnace, and from thence be allowed to flow together, through a convenient channel, to the spout by which they are admitted into the interior of the fire-place or furnace; but the tar or other substance, and the water, should be in contact prior to or at their entrance into the fire-place or furnace, and being so in contact should fall simultaneously upon the fire so burning within the fire-place or furnace; and if the fire-place or furnace be large, two or more of the spouts or channels for introducing the coal tar, or other substances, and water together, may be adapted to such fire-place or furnace in such manner and at such distances from each other as may be found most convenient. The stream of coal tar, or other of the before-mentioned substances, and of water respectively, is or may be regulated by means of stop-cocks or valves, either in or attached to the cistern or other vessel, or in any of the pipes or channels before-mentioned. The spout or other channel through which the coal tar, or other of the before-mentioned substances, and the water, are introduced into the interior of the inclosed fire-place or furnace, should be left open, so that a supply of atmospheric air may thereby be admitted to the said inclosed fire-place or furnace, care being taken that too large a supply of atmospheric air be not admitted. Although I prefer the heating, inflaming, and decomposing surface of a fire, burning within an inclosed fire-place or furnace, as aforesaid, in carrying my said improved process into effect, as most favorable to the complete and effectual combustion of the coal tar, or other of the before-mentioned substances, in conjunction with water as aforesaid, yet the same is not absolutely essential to the said process, for the combustion of the coal tar, or other of the before-mentioned substances, in conjunction with water, may be effected in a furnace, oven, or other close vessel, previously heated, and afterwards kept at a proper degree of heat, either by heat disengaged within the said furnace, oven, or close vessel, or by heat being applied externally, or in any other way that shall be found most convenient. It is not essential that the water employed in my said improved process should be fresh or pure water, for sea water and impure water, such as the bilge water in ships, and the ammoniacal liquor in gas works, will answer the purpose. The respective quantities and properties of coal tar, or other of the before-mentioned substances, and of water, proper to be admitted or introduced into the inclosed fire-place or furnace, oven, or other close vessel, will be found to vary according to circumstances and the materials used. The proportions of coal tar and water, which I have found productive of a good result, are one gallon of coal tar, to be be used simultaneously with one gallon and a half of water, and these qualities should be so regulated as not to fall upon the fire or other heated surface, as before-mentioned, in much less than two or three hours; but the proper proportions to be used may be ascertained by observing the interior appearance of the said inclosed fire-place or furnace, oven, or other close vessel, (which may be done at or through one or more of the spouts or other convenient channels provided for the introduction of the coal tar or other material and the water, or at or through one or more convenient apertures made for the purpose); for if water be in excess the flame will be weakened or extinguished; or if tar, or other of the before-mentioned substances, be in excess, then the flame will be obscured by smoke."

Mr. Rutter does not lay any claim to the apparatus or machinery employed in the process, but limits his patent right to "the mode or process of generating heat, by subjecting bituminous, oleaginous, resinous, waxy, and fatty

substances, or a mixture of two or more such substances, in a liquid state, in conjunction with water, ignition, combustion, and decomposition, in the manner before described."

In the London Mechanics' Magazine of October 5th we find the following further particulars:

As I find that the question I recently proposed to your valuable correspondent, Mr. Rutter, as to his new process, is inadvertently so worded as to be liable to misconstruction, I take the earliest opportunity to desire its correction.

The process in question is not for "making gas" only, but for *generating heat* for all the purposes to which that powerful agent is applicable, as must, indeed, have been by this time gathered from the articles on the subject in the Mechanics' Magazine. Gas is produced, it is true, in the first instance, from the combustion of the tar and the water, but it is instantaneously converted into flame, to be used *in any case where heat is required*—whether the manufacture of gas for illumination (to which it has been applied at Salisbury), the production of steam for numberless purposes of manufactures and navigation, or a thousand other equally important uses. Gaseous matter has, I understand, been before obtained from water to some extent, but only by means of processes too expensive and too complicated to be of general utility. I remain, Sir, yours respectfully, F. H.

London, Oct. 1, 1833.

From the same Magazine of October 19th, we also make the two following extracts:

The notices of Mr. Rutter's new process for generating heat have greatly interested me, and having some practical knowledge of the great difficulty of obtaining sufficient "stowage" for the fuel in steam navigation, without encroaching on the space required for other purposes, and disturbing the trim of the vessel too much, I am disposed to think that Mr. Rutter's discovery will do much towards changing "the face of the world," and to believe that the period is "now fast approaching, when communication by steam may be established with every part of the globe."

The economy of this plan, in *weight* and *cost*, will appear the greater, if we compare it with the expenditure on the present system. According to the data given by your correspondent, in No. 529, the account will stand as follows:

To produce an effect equal to 120 lbs. of Newcastle coal, will require 15 lbs. coal tar, say 20 lbs. water, and 25 lbs. coke, in all 60 lbs. But as water may be supplied from alongside as wanted, deduct 20, leaving 40 lbs. of fuel, which, on Mr. Rutter's principle, would produce an effect equal to 120 lbs. Newcastle coal, or three times the weight of the fuel at present used. If Mr. Rutter's data *only* approximate to the exact proportions, we cannot fail to be struck with the extravagant waste of fuel upon the present system. Every commander of a steam-vessel knows, or ought to know, that the ashes, *and cinders too*, which are thrown overboard, are not nearly equal to half the weight of coal consumed in a given time. From what has passed under my own observation, when in command of a steam-vessel, I am inclined to think that they do not exceed, in ordinary cases, 10 per cent. of the fuel consumed; and if so, there is a difference of 48 lbs. to be accounted for out of every 120 lbs. of coals consumed. Where this goes we can be at no loss to imagine, when we observe the immense volume of smoke which marks the course of a steamer at sea; even with the most careful stoking, a vast quantity of inflammable matter passes off unconsumed. Deducting the actual loss in this way, it appears not improbable it would be found that the difference of the total weight of the inflammable matters, efficiently *applied to the generation of steam*, would not be so great as it appears to be at first sight.

From the preceding statement it appears, that there is a balance in favor of Mr. Rutter's method of generating heat of 200 per cent., as compared with the weight of Newcastle coal, and that by loading a vessel with the same weight of fuel, to be consumed on this plan, she would be able to keep the sea three times as long as at present.

Another, and by no means unimportant advantage of Mr. Rutter's plan, is, that the material required being fluid, and withal of less specific gravity than water, it may be advantageously stored in tanks fitted to the vessel, in those spaces which are now comparatively useless, and may be so disposed as to serve in lieu of ballast, and thus render steamers less crank than they now are. As each tank is emptied it may be filled with water, so as to preserve the same trim during the voyage, which is by no means an unimportant consideration, as it is well known that swift vessels are much sooner put out of trim than others. The absence of the large funnel, which is now required, would be a great advantage, both in velocity and comfort in a seaway.

With regard to the comparative economy of Mr. Rutter's method of generating heat, it obviously depends upon the cost at which "the bituminous, oleaginous, resinous, waxy, and fatty substances, in a fluid state," can be procured.

Suppose that coal tar is used. This article could at one time, and may now, probably, be obtained for 1*d.* per gallon at the works, or even less. Taking it at 1½*d.* per gallon, and coke at 28*s.* per chaldron, weighing (say) 18 cwt., then the account will stand thus:

1½ gallons tar 1½*d.* 25 lbs. coke (say=¼ bush.) 4½*d*
—6*d.* cost of fuel on Mr. Rutter's plan, equal in effect to consumption of 120 lbs. Newcastle coal on the present system:

120 lbs. Newcastle coal = say 1¼ bush. at 9*d.* per bush., would cost 13½*d.*, or 125 per cent. more.

Something must be allowed for the expense of the apparatus for injecting the inflammable liquids into the fire, &c.; but even here an allowance should be made, on the other hand, for the increased room which would be available to other purposes than the stowage of fuel, for which it is now required—for the saving of the cost of the funnel—and also for the reduced expense of repairs to the hull of the vessel, in consequence of not being subject to those irregular strains in a gale of wind to which steamers are now liable.

I have no personal knowledge of Mr. Rutter, but I could not forbear addressing the foregoing observations to you upon the subject of his invention, which I find is already quibbled about, nay, by some decried, on account of its very simplicity! Let them remember the tale of Columbus and the Egg, and try to discover its application in the present case.

I am, &c. GEORGE BAYLEY.

Ipswich, Oct. 3, 1833.

I perceive by your last notice, that Mr. Rutter is preparing for publication a work on the application of his new principle, and I beg to assure him that he

has my sincere wishes for the complete success of his patent, &c.

It occurred to me, that about fourteen years since, in consequence of a paragraph which had then met my eye, I had been induced to make the following experiment: About equal portions of common tar and water were put into a half-pint glass retort, after which the orifice of the beak was reduced, by drawing out at the table blowpipe, to about one-eighth of an inch diameter. The retort being fixed over an argand lamp, the apparatus was taken into my garden on a dark night, and the contents of the retort brought to a state of brisk ebullition. As soon as vapor issued with rapidity, a light was applied, and in an instant I beheld a jet of flame eight or nine inches in length, constituting a brilliant firework, the intense heat of which was found capable of melting several refractory mineral substances. I lay no claim to originality in this little experiment, which is precisely the same in principle as Mr. Rutter's method, and this the following extract, which gave rise to my experiment, will show:

"American Water-Burner.—An apparatus, called the American Water-Burner, has been invented by Mr. Morey, of New-Hampshire. It is a rough blowpipe, but is applicable in many cases in place of a furnace. Tar is intimately mixed with steam, and made to issue from a small jet, in the manner of an eolipile, and the stream of matter being ignited, produces a flame of great size and intensity. It appears that the water is partly decomposed towards the middle of the jet, and that the heat is thus increased by increasing the quantity of active agents; but, whatever the exact effect, the water is found to be useful in preventing the formation of smoke, and increasing the combustion."—[New Monthly Magazine, April, 1819.]*

Perhaps, Mr. Editor, you will indulge me in a few more remarks. In the autumn of 1827, a scientific friend and myself succeeded in beautifully illuminating a very large room, then used as our laboratory, with gas obtained from the decomposition of resin; and being at the same time occupied with the oxydrogen blowpipe, in producing intense light by means of lime and other substances, it occurred to us that the light thus furnished would prove admirably adapted to the purposes of illuminating objects usually exhibited by the solar microscope. In the course of a few weeks, subsequently, the illuminating power of resin gas, and the principle of applying the light of lime to the microscope, were practically demonstrated in a lecture before the Canterbury Philosophical Institution. I believe it was early in the following year that I was informed a patent had been granted for lighting a town on the continent with "resin gas," and every body knows that, during the present year, the "gas microscope" has been brought out as one of the popular exhibitions of the metropolis.

Now I feel convinced, Mr. Editor, that both these plans were originated and carried into effect independent of any thing made public by me; and just as well am I satisfied, notwithstanding the extract previously given, that the principle of generating heat, now made known, is as purely original with Mr. Rutter. Coincidences of this kind have frequently happened, and the more men are taught to think for themselves, the more frequently they will happen, which, after all, is nothing more than another proof of the value of scientific acquirements. Mr. Rutter, I feel persuaded, will not mistrust my motives in offering these observations to his notice: had I not done so, it is very probable some one else would shortly have made him acquainted with the "American Water Burner," and perhaps might unjustly accuse him of plagiarism at the same time. I am, Sir, very truly yours,

W. H. Weekes.

Sandwich, October 18, 1833.

In conclusion, we beg to assure our subscribers that we have sent to the Patent Office at Washington for drawings and specifications of tke "American Water-Burner," which we fully expect will appear in our January number.

We have much to say on "Steam Travelling on Common Roads," but must defer it until our next.

Journeys from London to Greenwich.—In our last number we had the pleasure of giving an account of the first business-like journey performed by a steam-carriage on common roads; and we cannot but feel gratified at the demand which the accuracy of our information has produced.

It was very generally believed, particularly amongst horse-coach proprietors, that the public would be prejudiced against this new mode of conveyance; and in entering into arrangements for running steam-carriages, this objection has been raised as a reason for reducing the premium required by the patentees, it being stated that steam-carriages would run for a length of time at a loss, before the public would venture regularly to travel on common roads by steam. Sir Charles Dance, at the time of running between Gloucester and Cheltenham, had never discovered that such a prejudice existed, but that the contrary was really the case, every one appearing desirous of becoming a passenger. This point has however been further set at rest, by the same carriage, (which performed the journey from London to Brighton and back), having run for eight successive days from Wellington street, over Waterloo Bridge, to Greenwich, three times a-day, starting regularly at eleven, half-past twelve, and two o'clock, each day, a distance, in the whole, of about 250 miles, at an average running of ten miles per hour.

In order to call forth as little opposition as possible, from the coachmen and their attendant imps, at the same time to show that the public mind is by no means against the introduction of steam-carriages, Sir Charles Dance determined not to run for the ordinary charge, but the coach was advertised to run for two shillings and sixpence each person, to or from Greenwich, or the sum of four shillings to those who were desirous of going and returning: by such a course it was evident that curiosity would be the principal motive for going with the carriage. We are informed that, on an average, fourteen persons accompanied the carriage each trip. Such has been the interest displayed, that crowds of persons lined the road; and at either end of the journey so dense were the crowds, that, but for the command over the engine, and the accuracy of the driving,

* We have already alluded to this in our columns, at pages 169 and 182, vol. ii.

some serious accident must inevitably have occurred. In some of the journeys, the steam-coach was accompanied by many of our scientific men, amongst others Mr. Telford, Mr. Macneill, and others of our best engineers, who expressed themselves so much gratified with the success of Sir Charles Dance, that they have determined on running the carriage a journey between London and Birmingham, the more fully to demonstrate the practicability of using the power of steam on common roads; and the carriage has been taken off the Greenwich road for this purpose.

We have very carefully examined the steam-carriage, and observed the ease of its running, and believe, that when Messrs. Maudsly and Field shall have completed a carriage, it may be expected to run on an average of fifteen miles an hour, with light weight. It should be understood, that the present carriage was not built by these talented engineers, but that the boiler only is of their manufacture; nor can they venture to use its full power on the engines, as many parts of the carriage are not equal to bear the strain, whilst other parts are too strong and heavy; it may therefore be said, that the carriage, in having performed so much under all the circumstances, has the more positively proved the possibility of bringing this mode of conveyance into general application. We hope, in our next, to lay before our readers the result of the journey to Birmingham. We would here observe, that the boiler, on the lightness and strength of which every thing depends, has, after running several hundred miles, proved itself most effective, and may be considered as a very successful invention.

After this article was in type, we received the London Times of 9th November, from which we extract the following curious account of a new and important invention by Capt. Ericsson, and although its intention is to *supercede* steam power, we know no place more suitable to introduce it. The subject appears to have attracted considerable attention in England, and it will probably, if it should succeed according to the expectations of the inventor, produce important changes in the propelling power for machinery, travelling, &c.

We shall look for further accounts upon the subject with much interest, and lay them, when they are received, promptly before the public.

ERICSSON'S CALORIC ENGINE.—Various attempts have been made to construct engines founded on the principle of the expansion of atmospheric air by heat, but these attempts have still remained without practical success. The caloric engine invented by Capt. Ericsson, a large working model of which we have seen in vigorous operation, seems to promise results of a very different kind. Air and steam must now engage in a desperate and probably a deadly struggle for the mastery. If the sanguine, and we think not unreasonable, hopes of the inventor be realized, steam has seen its best days.

The principle of the engine is founded on the well known property of fluids, that they transmit their pressure equally in all directions. It consists of two cylinders of unequal diameters, the area of the pistons of the one being double that of the other. These cylinders are connected together by means of a series of pipes, called a regenerator. If air be condensed in these cylinders, it is obvious that the superior pressure exerted on the piston of the large cylinder will vanquish the pressure on the small one, and motion will take place till the larger piston has reached the top of the cylinder, whilst the small one has been pushed to the bottom. Here all motion would cease, if heated condensed air were not allowed to enter above the large piston, and below the small one, so as to depress the large one to the bottom of the cylinder, and raise the smaller one to the top. But this being done by sliding valves, exactly as in the steam engine, the motion is constantly kept up. On this principle, then, we could obviously have an air engine, which would perform its operations by the sudden heating and cooling of condensed atmospheric air. But this is not the principle which distinguishes the caloric engine from others of the same class. The marked difference lies in this—that the same heat is made to circulate through the engine and perform the same duty over and over again, instead of being thrown into a cold condenser or into the atmosphere as so much waste fuel.

The regenerator consists of a number of pipes, having numerous discs of metal placed within them, to make the air circulate in eddies, and either deposite its heat in the pipes, or receive it from them, according to the difference of temperature. These pipes are inclosed in a long cylinder of sheet iron, which has also discs of metal so arranged that the air, passing along the outside of the pipes, may also travel in a circuitous route, and deposit its heat, or receive it, according to circumstances.

The heated air, after having done its duty in the large cylinder, is made to circulate through the regenerator, and deposit a very large quantity of its caloric before it reaches the cold cylinder. The cold air from the small cylinder is at the same time passing along the interior of the pipes to the tubes above the furnace, and is thus carrying back the *same* caloric to do the same work over again. But though we have only mentioned atmospheric air as the fluid actually employed, it is obvious that any other fluid, whether aeriform or liquid, may be used in the same manner. But a simple statement of numerical facts, furnished us by the engineer himself, will be of more value in turning the attention of the public to this invention than any general observations which we can possibly make. The engine actually constructed has two cylinders of 18 inches stroke each, the one being 14 inches in diameter, the other 10 1-4 inches. The working pressure is 35 lbs. above that of the atmosphere. The fly-wheel performs 56 revolutions in a minute. The break-wheel is two feet in diameter, and loaded with a weight of 5,200 lbs. The power of the engine is calculated to be equal to five horses. The regenerator has seven tubes about seven feet long and two inches diameter. The engine requires only 2 lbs. of coal per hour for the power of one horse, and the whole heat which is actually lost out of this quantity, or not returned by the regenerator, is only 3 lbs. per hour; so that the other parts are lost by radiation, &c., which may be much diminished in an engine on a larger scale, and by surrounding certain parts by imperfect conductors.

The Great North Road in England—continued from page 260. [From the Monthly Supplement of the Penny Magazine.]

IMPROVEMENTS IN THE NORTH.—So greatly does the northern portion of our island incline or lean over to the west, that Edinburgh, while it is about 320 miles to the north of London, is also above 100 miles to the west of it—although the two capitals stand at about equal distances from the east coast. Edinburgh, on the east coast of Great Britain, is, in fact, rather farther west than Liverpool, which stands on the west coast. What is called the Great North Road from London, therefore, diverges considerably from a line drawn due north. The wide level country, which generally prevails as far as to the heart of Yorkshire, enables it to pursue up to that point a course nearly perfectly straight. The first formidable obstacle, indeed, which it meets with to prevent it from following the shortest line to the Scottish metropolis, is interposed by the Chevoit hills, which form the north-west boundary of Northumberland. These hills, at their northern extremity, approach so close to the sea as to leave only a pass of a few miles broad, through which the road at this part of its course can be carried. Hitherto the town of Berwick, which is on the coast, and at a short distance beyond the termination of the Chevoit range, has been assumed as the point which should determine the direction of the first part of the road between the two capitals. This has made the deflection of the line to the west less than it otherwise would have been; for Berwick, although far west of London, is still considerably to the east of Edinburgh.

The direction of the southern portion of this road, then, may be considered as necessarily regulated, not by the relative positions of London and Edinburgh, but of London and Berwick, or another point but a few miles to the westward of the latter town. The route followed by the mail at present, in fact, is very nearly the shortest line between London and Berwick, subject merely to such slight deviations as are required in order to make it touch certain great towns. The length of this portion of the road, which passes through Huntingdon, Stamford, Doncaster, York, Darlington, Durham, and Newcastle, is 342 miles; the whole distance from London to Edinburgh being 399.

The first improvements which it falls within the plan of the present article to notice are those which have been recently made on the northern portion of this line of road between London and Berwick. We shall begin by merely adverting to the magnificent approaches which now lead to the town of Durham, the elevated situation of which formerly rendered it of such difficult access. The new entrances, which have in a great degree overcome the obstacles presented by the nature of the ground, are excellent specimens of engineering skill, and do honor to the local trusts. They would probably, however, have remained unexecuted but for the stimulus given to these bodies by a committee of the House of Commons, which had under its consideration the defective state of the communication between London and Edinburgh. We may here also mention, as having originated in the recommendations of the same committee, the handsome new bridge over the North Tyne at Morpeth, constructed by Mr. Telford, after the model of the bridge of Neuilly, near Paris.

But the most important improvements in this quarter, and those to which we would particularly direct attention, are the alterations which have recently been effected, or are in progress of execution, on the portion of the road to Edinburgh immediately beyond Morpeth. Here the Chevoit hills run almost parallel to the coast, to which they at the same time approach so closely, that what we may call their roots stretch across the intervening space in the shape of so many successive elevations, while the hollows between are occupied by rivers more or less considerable, all having a direction at right angles to the line of the road. This extreme inequality of surface has hitherto, as already intimated, forced the road close upon the sea: but even while thus retiring as far as possible from the mountains, it has still not been able to avoid a remarkable steep ridge called Birnside Moor. The gentlemen of Northumberland, however, have at last, aided by the great exertions of Sir John Marjoribanks, of Leeds, effected the union of several of the local trusts into one, and thereby enabled themselves to raise the sum of £12,000, which they are now in the course of expending in carrying the road through a series of vallies lying farther to the west, in place of this elevated moorland. The whole of this improvement will be completed during the present year; and although much still remains to be done to make the road what it ought to be in the more immediate vicinity of Morpeth, the alteration effected here will deserve to be accounted one of the most valuable works of public utility which have been lately accomplished in these islands.

The road, following the new direction thus given to it, will now leave Berwick to the right, and, instead of running along the coast, as it does at present, by Dunbar, and thence turning around in a due west direction by Haddington, will proceed by Wooler and Coldstream in very nearly a straight line to Edinburgh. The saving, by this route, we believe, will be above 10 miles, the distance from Edinburgh to Morpeth being reduced from 104 miles to about 93½. It is only lately, however, that the road by Coldstream, which passes through a very hilly country, has been brought to such a condition as that the mail could travel on it. The exertions of the gentlemen of Berwickshire and Mid-Lothian, by which this important object has been at last accomplished, rather preceded those of the Northumberland trustees to which we have just adverted, their operations having commenced in January, 1828.

From a report now before us, by the clerks of the Berwickshire trust, it appears that the improvements effected on what is called the Greenlaw Turnpike Road embrace the reduction of numerous severe pulls of from one foot in six to one foot in twelve, occurring between Deanborn, the northern extremity of the trust, and Coldstream, to gentle ascents of from one foot in twenty-five to one in forty; besides the repair of the bridge over the Blackadder, at the east end of Greenlaw, and of that over the Tweed, at the east end of Coldstream. Including £2,100, expended on the Coldstream bridge, the whole cost of these improvements, up to the 8th of March last, had amounted only to £23,145. Of the adjoining portion of the road in the Edinburgh direction, which is under the care of the trustees of the Dalkeith district, a line of about eight miles, extending from the south-east boundary of the county of Mid-Lothian to the north end of Fordel Bank, near Dalkeith, has within the same period been shortened, and the passage on it rendered much more safe and easy, by altering the course of the road in some places, by cutting down and banking over some difficult and dangerous passes, and by building several new bridges.

The principal bridges are the bridge over Cranstown Dean, and the bridge over the Tyne, at the north end of the village of Ford Pathhead, called the Lothian bridge. Cranstown Dean bridge is forty-six feet in height, and consists of three semi-circular arches of seventeen feet span: the whole building is of ashler, and the piers being only three feet in thickness, the bridge has a very light appearance.

Lothian bridge is eighty-two feet in height, and consists of five semi-circular arches of fifty feet span, surmounted by ten segment arches of fifty-four feet span and eight feet of rise. The piers are eight feet thick by twenty-eight feet broad, and hollow in the centre, as are also the abutments.

The whole building is of ashler, thereby presenting a happy combination of durability and lightness, and adding much to the ornament of the adjoining grounds. The embankments at the ends of the bridges are planted up with evergreens.

Of the embankments, that at Cotterburn is of the length of five hundred yards, and will contain 200,000 cubical yards of earth. The extreme depth of cutting in the line of the road will be thirty-two feet. Besides the general improvement of the line of road, these operations have opened many fine prospects of the neighboring beautifully wooded and highly cultivated country. The expense has amounted to between £20,000 and £30,000, besides a large sum of money which was previously expended on the improvement of that part of the line which is situated between this district and Edinburgh.

The city of Edinburgh stands within two miles of the great arm of the sea called the Frith of Forth, which, at the part immediately north of the Scottish capital, is about seven or eight miles broad. Steamboats and other vessels put across this estuary at all hours from Leith, the port of Edinburgh, and from Newhaven, about a mile to the west of that town, both to Burnt Island, Pettycur, and Kinghorn, which are directly opposite, and to Kirkaldy, Dysart, Leven, Ely, Pittenweem, and Anstruther, which lie farther to the east. The common passage for travellers to the north is from Newhaven, (where there is a chain pier,) to Pettycur. As this passage, however, is subject to be occasionally interrupted, (though since the introduction of steam navigation that is a circumstance which has very rarely happened,) the mail, instead of crossing here, proceeds along the coast of the river to Queensferry, about twelve miles farther west, where the channel is contracted to the width of about a mile and a half. But before leaving Edinburgh we cannot help noticing, although not upon any of the great lines of road leading from that capital, the magnificent bridge, called the Dean bridge, which has lately been thrown across the chasm formed by the river or water of Leith to the north of the city. The reader will find a notice of this structure, which was only finished about the beginning of the last year, in the "Companion to the Almanac" for 1832. This bridge, which has been erected after a design by Mr. Telford, almost at the sole expense of John Learmouth, Esq. (late Lord Provost,) to whose property it forms a communication, consists of two series of four arches each, the one surmounting the other. The span of each of the upper arches is 96 feet, and the road-way passes at the height of more than 120 feet above the level of the water below.

From Queensferry the present route of the mail is directly north by Kinross to Perth, from which point, crossing the Tay by a bridge, it takes its way along the northern banks of that river in an eastern direction to Dundee, and from thence to Arbroath on the coast. The common road, however, from Edinburgh to Dundee, runs in nearly a straight line from Pettycur through the county of Fife, and across the Frith of Tay, which at Dundee is about two miles in breadth. There is on this passage an excellent steamboat of a peculiar construction, the paddles being placed in the middle, as if there were two boats joined, and the form being such that it moves equally well with either end foremost. The distance from Edinburgh to Dundee by this road is not quite 43 miles, whereas, by that which the mail takes, for the sake principally of avoiding the two ferries over the Forth and the Tay, it is not less than 69 miles. From Dundee to Arbroath is 17 miles more, so that the whole distance by this circuitous route from Edinburgh to the latter place is 86 miles, the distance in a straight line being only about 50. In getting from Berwick to Arbroath, again, the mail travels about 143 miles, while a straight line drawn between

these two points would not measure 60. The voyage by sea from the one place to the other does not exceed the last mentioned distance.

The road between Edinburgh and Montrose, which is 12 miles to the north of Arbroath, has been constructed at a cost of not less than £100,000, reckoning only the outlay since the commencement of the present century; but as only a small portion of this sum has been expended within the last three or four years, the consideration of the improvements which it has effected does not fall within the scope of our present remarks. We pass on, therefore, to notice the bridge which has just been carried over the South Esk at Montrose. This town stands on the north bank of the river called the South Esk, which here falls into the German ocean; and we cannot better explain its singular situation than by extracting the description given of it in a report made in 1823 by Mr. Buchanan:

"The river South Esk, at Montrose, is remarkable for its broad, deep, and very rapid stream. But the great width of the river, and the current, deep and rapid beyond example indeed in this country, are not owing to the magnitude of the South Esk river itself, but to the singular manner in which the discharge of its waters into the sea is here combined with the action of the tides and the configuration of the adjacent ground.

"The town stands on a gently rising ground, in one of those low sandy flats which occur so frequently on the shores of the German ocean, and which, from their slight elevation above the sea level, and other circumstances, appear to have been once overflowed by the water. It has the German ocean on the east, at the distance of about half a mile, and to the west is a tract of low and level sands, above four square miles in extent and nine miles in circumference, through which the South Esk winds its way to the sea, passing close to the town on its south side. These sands lie below the level of high water, and above the level of low water; and the river opening a communication with the sea, it necessarily happens, that every rising tide rushes up the channel of the river, and inundates the whole of this sandy flat to the west of the town, which is again left uncovered by the reflux of the tide. The channel through which this great body of water is alternately poured in and discharged is suddenly contracted, at the south end of the town, to the breadth of 700 feet at high water, and 400 feet at low spring tides; and in consequence of this the stream rushes in or out with great violence, according as the tide is either flowing or ebbing. This low land, over which, at each return of the tide, are spread the waters of the ocean, after they have made their way through the narrow channel of the South Esk, is called the Basin, which forms a striking object in the scenery of the place, appearing, when the tide is full, a large and beautiful lake, and in a few hours afterwards, when the waters have retired, a desolate and sandy marsh."

Between the basin and the sea, the river is at one place divided into two channels, by a small island called the Inch; but the two streams again unite into one before they arrive at the sea. About thirty years ago, when the road from Edinburgh to Aberdeen was first constructed, a wooden bridge was erected across the most northern of these channels, which is by far the broadest; the other being crossed by a stone bridge of one arch, which is so narrow that, says Mr. Buchanan's report, "it has contracted the channel of the river to at least one-fourth of its original breadth." At the same time the channel of the northern stream had been greatly contracted by the faulty construction of its wooden bridge. The effect of this unnatural confinement of so violent and rapid a stream has been to deepen the channel on the northern side, not less than five or six feet in many parts; so that the original bottom having been carried away, the foundations on which the piers rested were in danger of being undermined. To prevent this result wooden piles were driven in, which served as a sort of wall to repel the current. But, notwithstanding this expedient, the bridge was still found to labor under the incurable defects of its original construction. In particular, the wood was so damaged by the ravages of sea worms, of the genus designated *Oniscus*, that the expense of keeping it in repair was very great. It was accordingly determined a few years ago to remove this wooden structure altogether, and to supply its place by a suspension bridge. Such a bridge has been accordingly erected, after a design by Captain Samuel Brown, of the Royal Navy.

The distance between the towers at the two extremities of this bridge, measured from the centre of each, is 432 feet. The height of each tower is seventy-one feet; namely, twenty-three feet and a half from the foundation to the roadway, forty-four feet from the roadway to the top of the cornice, and three feet and a half forming the entablature. The breadth of each tower, at the termination of the cut-waters, is forty feet and a half, and thirty-nine and a half at the roading. The archway by which each is perforated is sixteen feet in width by eighteen in height. The four counter-abutments for securing the chains are respectively 115 feet distant from the towers, (reckoning from the centre of the tower to the face of the farthest wall of the chambers,) and consist each of an arched chamber, a strong counterfort or abutment, a tunnel, and lying spandrel arch. The width of the bridge is twenty-six feet within the suspending rods. The bars of which the main chains consist, measure eight feet ten inches from centre to centre of the bolt-holes, five inches broad between the shoulders, and one inch thick throughout. All the main links or bars are of the same thickness, except those in the towers, which are a sixteenth

of an inch thicker, and of length to suit the curve of the cast iron saddles. Each main suspending chain, of which there are two on each side of the bridge, one over the other, placed one foot apart, consists of four lines of chain bars. The joints of the upper main chains are over the middle of the long bar in the lower chain; and the suspending rods which support the beams on which the roadway is laid, are five feet distant from each other. The chains are of wrought cable iron; the beams are of cast iron, formed with open spaces, twenty-six feet eight inches long, ten inches deep at the neck of the tenons, and one inch thick in every part between the flanges. The whole cost has been a little above 20,000 pounds.

To this account we have only to add, that the centre of the arch of the stone bridge which crosses the southern stream has also been taken down, and a revolving drawbridge erected in its stead, by which vessels are allowed to pass and repass. The communication across the South Esk at Montrose, therefore, may now be considered to be as perfect as it can be rendered or desired.

From Montrose the road follows the line of the coast by Bervie and Stonehaven to Aberdeen, a distance of thirty-seven miles. The situation of New Aberdeen is extremely similar to that of Montrose, standing as it does on the north side of the large and rapid river Dee. Until lately, the only bridge across this river was the magnificent old bridge erected by Bishop Elphinstone in the early part of the sixteenth century. Within the last three years, however, a suspension bridge has been erected between the town, and a road made at great expense, to communicate with the old one.

In this bridge the width between the stone piers is 200 feet; the breadth of the roadway is 22 feet, and its height above high water is 18 feet. It is within the recollection of many persons now alive, that the whole of the land at present in cultivation around Aberdeen was one brown heathery moor. Such is still the case with the whole district through which the above mentioned new road has just been completed; but from this operation we may probably date the commencement of a course of improvements, which will ere long transform this hitherto bleak and sterile tract into cultivated and productive fields. And here, while speaking of New Aberdeen, we cannot help adverting to the small expense, both of money and of time, with which, thanks to steam navigation, a person residing even at so distant a point as London may now accomplish a visit to this handsome northern city, remarkable for its rapid increase, the industry of its inhabitants, and the fine granite buildings of which it is entirely constructed. The voyage by sea is very little, if any thing, longer than to Edinburgh, and is usually performed by the steamboats in little more than fifty hours.

As New Aberdeen is situated on the north side of the Dee, so Old Aberdeen stands on the south side of the Don. The Don, until within these few years, was crossed at Old Aberdeen by a very ancient bridge, called the *Brig of Balgownie*. We refer the reader to an interesting passage in Sir Thomas Dick Lauder's volume, entitled "An Account of the Great Floods of August, 1829, in the Province of Moray and adjoining Districts," for some curious particulars regarding this structure.

The new bridge of Don, which was built by Mr. Gibb, after a design by Mr. Telford, is about 520 feet in length, and consists of five arches, each of seventy-five feet span, and twenty-four feet rise. The total expense of the erection was £14,000. The effect of this improvement is to shorten the road by about half a mile, and to avoid three steep hills over which it was formerly carried. This structure, although in an unfinished state when the great flood of 1829 occurred, escaped on that occasion without injury. It was completed towards the end of the following year.

At Aberdeen the mail road leaves the coast, and proceeds across the country in nearly a straight line by Inverury, Huntley, Keith, and Fochabers, to Elgin, the county town of Morayshire. The whole distance from Aberdeen to Elgin is sixty-seven miles. The road is throughout excellent; and notwithstanding that it passes over a great deal of hilly country, is so artfully conducted that hardly a single heavy pull is encountered the whole way. Immediately beyond Fochabers, it is met by the impetuous and formidable river Spey, forming the boundary of the province of Moray, which, notwithstanding its northern situation, is one of the fairest portions of the island, and one of those in which vegetation is earliest. It used, however, to be in a manner separated and cut off from the rest of the country by this dangerous mountain torrent, until about twenty-five years ago, when a bridge was first built across it at Fochabers. It consisted of four arches, of which two were of ninety-five and two of seventy-five feet span each, the total length of water-way being 340 feet. But this bridge, during the floods of August, 1829, which destroyed or damaged nearly one hundred others, had the two arches next the left bank carried away, of which Sir Thomas Dick Lauder has given a striking account.

Various bridges over the river Findhorn, which bounds Morayshire to the west, and over the stream of the Lossie, on which the town of Elgin stands, were swept away on the same occasion, so that the country was at once cut off from all communication with the surrounding parts. Active measures, however, have since been taken to repair the ruin produced by this visitation, and new bridges have already been erected in the line of the great road over all the three rivers.

The bridge at Elgin, over the Lossie, of 80 feet span, is partly of cast metal and partly of timber.

From Elgin the mail proceeds along the coast of the Moray Frith to Inverness, and from thence westward to the termination of that estuary, when it crosses the Beauly Water, and ascends northwards to Dingwall, on the Frith of Cromarty. Pursuing for some time the direction of the northern coast of that Frith, it then arrives at Tain, on the Dornoch Frith, which it crosses by Meikle Ferry; after which the road runs along the coast for seventy miles, till it leaves it at Wick, and cuts across the country to Thurso on the Northern Ocean. This is the farthest point to which the London mail proceeds. Thurso, by the road which has been described, is 783 miles distant from London; and the journey is now accomplished by the mail, all stoppages included, in four days and fifty minutes.

The portion of the road which has just been described from the Beauly Water to Thurso has been constructed and is maintained in repair by the commissioners appointed under the act of parliament for superintending Highland roads and bridges. The works conducted by the parliamentary commissioners from the year 1803, when they commenced their operations, have done more to advance the civilization of the Highlands than all the other attempts of government for that purpose in the course of the preceding century. Speaking of what had been done up to 1817, Mr. Telford, the engineer, asserts, in a statement which will be found quoted at greater length in the "Results of Machinery," chap. vii, that the money then expended "had been the means of advancing the country at least one hundred years." The report made by the commissioners in 1828 (the fourteenth) contains an interesting communication, addressed to the late Lord Colchester, by Mr. Joseph Mitchell, on the improved state of the Highlands since the commencement of the works executed by the commissioners; with an abstract of a few of the statements presented in report, with which we may fitly conclude the present paper.

So little communication was then wont to be between the northern counties of Scotland and the south, owing to the want of roads, that, until of late years, the counties of Sutherland and Caithness were not required to return jurors to the circuits at Inverness. "Before the commencement of the present century, no public coach, or other regular vehicle of conveyance, existed in the Highlands. It was not till 1806 and 1811 that coaches were regularly established in these directions, being the first that ran on roads in the highlands. Since the completion of the parliamentary works, several others have successively commenced; and during the summer of last year, no less than seven different stage coaches passed daily to and from Inverness, making forty-four coaches arriving at, and the same number departing from, that town in the course of every week. * * * Post-chaises, and other modes of travelling have during the same period, increased proportionably; and, instead of five post-chaises, which was the number kept in the town of Inverness about the year 1803, there are now upwards of a dozen, besides two establishments for the hire of gigs and riding horses. * * * The number of private carriages in Inverness and its vicinity has likewise increased remarkably during the last 25 years, and no less than 160 coaches may now be seen attending the Inverness yearly races; whereas, at the commencement of that period, the whole extent of the Highlands could scarcely produce a dozen; and at no very distant date previously, a four-wheeled carriage was an object of wonder and veneration to the inhabitants. In 1715, the first coach or chariot seen in Inverness is said to have been brought by the Earl of Seaforth. In 1760 the first post-chaise was brought to Inverness, and was for a considerable time the only four-wheeled carriage in the district. There are at present four manufactories for carriages at Inverness."

Formerly there were no inns; inns are now built, except in one instance, along the roads constructed by the commissioners, extending in length to upwards of 900 miles. The mails, which used to be carried only on runners' backs, are now sent to all the considerable towns in coaches, and three or four times a week to places off the direct line of road, to which they used to come only once. Finally, agriculture has received a prodigious impulse from these improvements; the value of property has been greatly increased; trade has been promoted; and the general condition of even the poorest of the inhabitants has been ameliorated by numerous accommodations and comforts which were formerly entirely out of their reach.

The Undulating Railway. By Junius Redivivus. [From the London Mechanics' Magazine.]

Sir,—Since I last wrote to you I have seen Mr. Badnall's treatise on railway improvements; but I must confess I see therein no statement which tends to shake my incredulity on the subject of hill and valley locomotion. I still prefer the level, and doubt not of its being the most economical railway. In the way of argument I have nothing to add to my former letters on the subject. I did, indeed, wish to ask one or two questions, which I had intended to put when I read your review, and the extract, stating that the moving power of the experimental carriage was a steel spring coiled round a barrel; but I have since found that a writer in the Magazine edited by the Messrs. Cobbett has forestalled me. It is by him stated that the experiments were unfair; that in the case of both the level and the curve, the carriage was

traversed backwards along the whole line, and that on the curved line the distance traversed was considerably greater than on the horizontal line, consequently that the spring was wound up to a greater amount of tension. He states further his belief, that if the carriage were wound up on the level road, and then placed in motion on the curve, that it would stop half way from want of power. Whether this statement be correct or not I cannot pronounce, not having seen the trials, but the winding up of a spring is assuredly a matter of considerable importance, when we consider that half a turn of the barrel, when nearly wound up, gives more power than several turns at the commencement.

Mr. Badnall says, p. 74, "In allusion to the comparative difference in the speed between the two curved railways, in the preceding statement, and in the statement at p. 67, I confess myself in difficulty." At p. 77 he says, "The advantage gained over a common horizontal railway will be in proportion to the length and depth of descent." Now, supposing the moving power to be a coiled spring, it is quite clear that the tension would increase, and consequently the power would increase, in proportion to the number of turns, and in a compound ratio. If this be the case, the "difficulty" will be solved without accounting for it by the "vibration."

From the letter of Mr. Stephenson, quoted in Mr. Badnall's book, I take the following extract:

"This sort of force (*periphugal force*) perhaps not being thoroughly understood, you will allow me to compare it to a man on horseback, riding at full speed, and the animal stopping himself with all the power he is master of; we should in such a case naturally expect to see the rider thrown forward, taking along with him both bridle and stirrups."

With all deference to the opinion of Mr. Stephenson, I beg to remark that I have been for some years in the habit of studying the laws of "forces," in this very species of involuntary experiment. I have seen numerous riders thus shaken out of their saddles—technically called "purchasing an estate"—and with nearly the result he has described: but invariably their future progress was arrested by friction, both on levels and up hill, the momentum being absorbed by the material on which the falling body impinged, and sometimes so rapidly that it dragged life along with it. Down hill, it is true, the momentum has occasionally been of considerable avail, unless a thicket or patch of aloes, or spiry larch-thistle, happened to intervene as a recipient. Even thus I suspect the "periphugal force" would impinge upon and be absorbed by the upward ascent of an undulating railroad.

At page 84 Mr. Badnall talks of having given a *limited* power to his spring, winding it up ten feet and six feet. Why was this small power selected? The experiment seems on too small a scale to justify any reliance on the result. I will state an experiment, which, if it give a result in favor of undulation, when accurately tried, I shall think that there is more in Mr. Badnall's scheme "than is dreamt of in my philosophy."

Make two railroads side by side, with the ends and beginnings parallel. Let one be an horizontal road, say two hundred feet in length. Let the other be increased in actual length, by means of any undulating form Mr. Badnall may choose, till it measures two hundred and twenty-five or fifty feet. Then let a barrel spring be adapted to a carriage, so that, when traversed backwards on the horizontal road, it may just have power enough to reach the extremity again. Then take the carriage, thus wound up, and place it on the undulating road, and if it reach the extremity of that also, I shall be ready to acknowledge the triumph of Mr. Badnall's *principle*. But, even then, unless it perform something more, there will be no gain in point of economy, but, on the contrary, a considerable loss, by the extra expense of material consumed in the road. And here I leave the matter for the present.

I remain, yours, &c.

JUNIUS REDIVIVUS.

P. S.—Illness, and the pressure of occupation, have hitherto prevented me from answering "R."

The Undulating Railway. By S. D. [From the London Mechanics' Magazine.]

SIR,—If you examine the author's account of his invention as exhibited in your extracts, you will find that, in paragraph 3, he says, "that throughout the ascent the pressure upon the rails, and consequently the amount of friction, is precisely the same as it was down the descent A B, viz. as much less than it was on

the horizontal line E A as the line C D to D C." Now, surely the amount of friction is proportional to the lines representing the pressure upon the rails, which are C P and C G, not C D and D C. But even with this understanding, let us see if the inference be correct.

In paragraph 5 we find it stated, "that although the disposable power of gravity in opposition to pressure is only as C D to C P, yet this is no criterion of the extent of advantage gained in speed; in fact, C D may as properly be stated to represent the saving in friction."

If C D may be stated to represent the saving in friction, throughout the whole descent, it may also be stated to represent an augmentation of friction upon the whole ascent; so that C P being the measure of the former, C P + C D will be that of the latter quantity. With this in mind, let us see what the author says farther on, that if "the power employed upon the ascending part of the undulation were only just sufficient to overcome the friction and resistance of atmosphere, the carriage would naturally, as proved by the action of the pendulum, rise the ascent B E in the precise time it occupied in traversing from A to B."

Now, on the horizontal railway the friction is represented by the C G, but upon the ascent of the undulating railway by C P + C D, which being greater than the other, it would oppose more force to the progress of the carriage, and it would require more power to overcome it.

In thus examining the author's explanation I am led to think that the amount of friction is not less on the undulating than on the horizontal railway.

I am, sir, your obedient servant,

S. D.

May 20.

Of the Orders of Architecture. [Concluded from page 264.]

Construction of Arches.—If the weights of the voussoirs in an arch are all equal, the arch of equilibration is what is termed a *Catenarian* curve, the same that a chain or cord of uniform thickness would assume, if hanging freely, the horizontal distance of the points of suspension being equal to the span of the arch, and the depth of the lowest point of the chain being equal to the greatest height of the arch.

If the figure of the chain were reversed, the joints being such that the force, which was a *pull* in the first situation, becomes a *thrust* in the second, the chain would support itself, and remain in *equilibrio*.

The *catenaria* is remarkable for this mechanical property. That a chain hanging in that curve has its centre of gravity *lower* than if it were disposed in any other line, its length continuing the same, and also the points from which it is suspended. Therefore, an arch constructed in this form has its centre of gravity the *highest* possible.

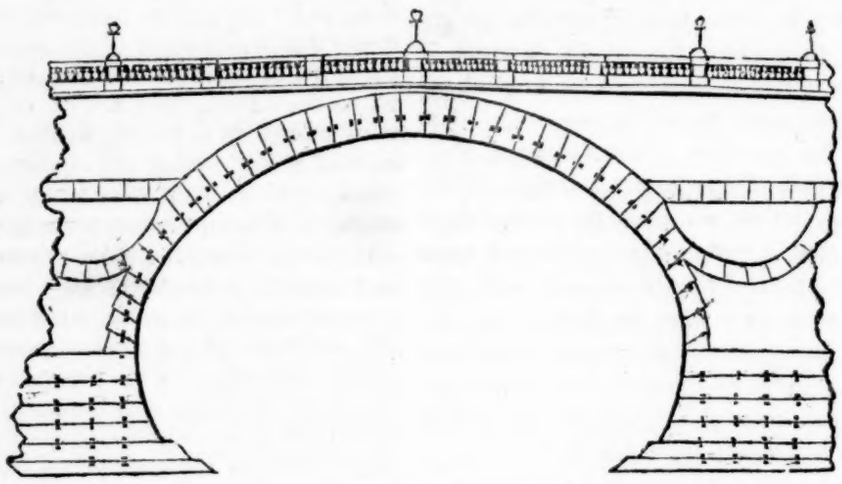
But the supposition of an arch resisting a weight, which acts only in a vertical direction, is by no means perfectly applicable to cases which generally occur in practice. The pressure of loose stones and earth, moistened as they frequently are by rain, is exerted very nearly in the same manner as the pressure of fluids, which act equally in all directions: and even if they were united into a mass, they would constitute a kind of wedge, and would thus produce a pressure of a similar nature, notwithstanding the precaution recommended by some authors, of making the surfaces of the arch-stones vertical and horizontal only. This precaution is, however, in all respects unnecessary, because the effect which it is intended to obviate is productive of no inconvenience, except that of exercising the skill of the architect. The effect of such a pressure only requires a greater curvature near the abutments, reducing the form nearly to that of an ellipsis, and allowing the arch to rise at first in a vertical direction.

A bridge must also be so calculated as to support itself without being in danger of falling by the defect of the lateral adhesion of its parts, and in order that it may in this respect be of equal strength throughout its depth at each point, must be proportional to the weight of the parts beyond it. This property particularly belongs to the curve denominated *logarithmic*, the length corresponding to the logarithm of the depth. If the strength were afforded by the arch stones only, this condition might be fulfilled by giving them the requisite thickness, independently of the general form of the arch: but the whole of the materials employed in the construction of the bridge must be considered as adding to the strength, and the magnitude of the adhesion as depending in a great measure on general outline.

We must examine in the next place what is the most advantageous form for supporting any weight which may occasionally be

placed on the bridge, particularly at its weakest part, which is usually the middle. Supposing the depth at the summit of the arch at the abutments to be given, it may be reduced considerably, in the intermediate parts, without impairing the strength, and the outline may be composed of *parabolic arcs*, having their convexity turned towards each other. This remark also would be only applicable to the arch stones, if they afforded the whole strength of the bridge, but it must be extended in some measure to the whole of the materials forming it.

If, therefore, we combine together the curve best calculated for resisting the pressure of a fluid, which is nearly elliptical, the logarithmic, and the parabolic curves, allowing to each its due proportion of influence, we may estimate, from the comparison, which is the fittest form for an arch intended to support a road. And in general, whether the road be horizontal, or a little inclined, we may infer that an *ellipsis*, not differing much from a circle, is the best calculated to comply as much as possible with all the conditions, as represented by the above figure, which exhibits a view of the middle arch of Blackfriar's Bridge, London.



Curious Facts and Experiments.—The "Philosophical Transactions" contain a very curious paper on hybernation, from the pen of Dr. Marshall Hall. From the fact that the peculiar condition of certain mammalia in the winter season,—in other words, the state of hybernation of these animals,—bears so striking an analogy to ordinary sleep, as to justify the expectation of some interesting results being deduced from considering the two in connection, the learned doctor has paid very minute attention to the state of the hedgehog, dormouse, and bat, during sleep, and he has come to a conclusion respecting it which does not appear to be consistent with the testimony of former observers. He states that the animal, in ordinary sleep, experiences a striking diminution of the power of respiration: that the acts of breathing become less; and that its temperature decreases many degrees below the average of what it is in the active state of the animal. Its capability of enduring the abstraction of the atmospheric air is increased to a corresponding extent. Such is the character of the natural sleep of hybernating animals, and it is distinguished from hybernation only in the degree in which the symptoms of the ordinary sleep are developed. In this case, that is, in true hybernation, the function of respiration is nearly altogether suspended; at least, the phenomena which result from experiments on animals during hybernation are all confirmatory of such a conclusion. The doctor has shown, likewise, that the air which surrounded the animal whilst in the hybernating state yielded, at most, but very slight signs of any absorption being experienced by it. He placed a bat in a contrivance so constructed as to be capable of indicating the minutest amount of the absorption of gas. In the interval of 60 hours, after a most carefully conducted experiment, he found that three-quarters of a cubic inch of gas had been absorbed. The amount of the diminution in the quantity of gas required by the hybernating animal may be estimated by stating that the average consumption necessary to him in the active state would be an equal quantity of gas in about half the above number of minutes. In the process for determining the absorption of hybernating

animals, the nicest precautions are demanded. Whilst the air to be respired is secured against any addition, it is likewise necessary to ascertain constantly the comparative temperature of the animal and of the atmosphere. The author recommends that the experimentor should obtain a mahogany box, with a glass lid, divided horizontally at its middle part by a fold of strong ribbon, and of such dimensions as just to contain the animal. The bat is then to be placed upon the ribbon, and enclosed by fixing the lid in its place. A thermometer with a cylindrical bulb is then to be passed through an orifice made in the box, on a level with the ribbon, under the epigastrium of the animal, and left in this situation. The thermometer should be so placed as to be seen without disturbing the inmate, whilst its indications can be compared with those of another thermometer hung up in the room to express the variations in the temperature of the atmospheric air. The doctor adds, that the layer of silk and the portion of air underneath are sufficient to protect the animal from the immediate influence of the temperature of the table, or whatever may be the support of the box. The phenomena of hybernation prove beyond all doubt the power of the animals who undergo it to sustain with impunity the privation of the atmospheric air. But the most extraordinary feature in this general fact is, that the exercise of this power is limited exclusively to the term of hybernation: for Dr. M. Hall placed a dormant bat in water, in which it remained immersed for eleven minutes, and came out uninjured; whilst a hedgehog, in the active condition of its existence, was put in the same element, and died in three minutes, the ordinary time in which drowning kills mammalia. In a paper previous to the present one, the same author had shown that in those cases in which the amount of respiration is small, the degree of irritability is high, and that, consequently, during the state of hybernation, the irritability of the animal is very sensibly augmented.

Now, if this reasoning were correct, it would necessarily follow, that, if the head of an animal were suddenly removed, and the heat of the heart observed afterwards, that heat would be found to continue longer if the experiment were tried in the hybernating state, than when it was done in the active condition of the animal. This result would undoubtedly show that irritability did increase when the respiration was diminished. The fact was placed beyond all doubt by Dr. M. Hall, in the following experiment: "On March 9th, soon after midnight, I took a hedgehog, which had been in a state of uninterrupted lethargy during 150 hours, and divided the spinal marrow just below the occiput; I then removed the brain, and destroyed the whole spinal marrow as gently as possible. The action of the heart continued vigorous during four hours, when seeing no prospect of a termination to the experiment, I resolved to envelope the animal in a wet cloth, and leave it until early in the morning. At seven o'clock, A. M., the beat of both sides of the heart still continued. They still continued to move at 10 A. M., each auricle and each ventricle contracting quite distinctly.

"At half past 11 A. M., all were equally motionless; yet all equally contracted on being stimulated by the point of a pen-knife. At noon the ventricles were alike unmoved, on being irritated as before; but both auricles contracted. Both auricles and ventricles were shortly afterwards irritable." A few weeks after this experiment, the spinal marrow of another hedgehog, in a state of activity, was simply divided at the occiput; the result was, that the beat of the left ventricle of the heart ceased almost immediately; that of the left auricle in less than a quarter of an hour; the right ventricle did not cease to beat before two hours from the time of death, whilst the right auricle ceased long before, though not so soon as the left auricle. The conclusions, then, which we are entitled to draw from these facts, are, that the irritability of the heart is strikingly increased in prolonged lethargy; and that in this state of the animal system the action of the heart continues without any dependence on the functions of the brain or spinal marrow. The general opinion hitherto has been, that during hybernation the sensibility of the animal is greatly impaired. The contrary is maintained by Dr. Hall, on the evidence of his own senses, for the slightest touch applied to one of the spines of the hedgehog, during hybernation, is sufficient to rouse it, and induce it to draw a deep respiration. The same respiration holds good with respect to the power of the animal to use its muscles. This remains perfectly unimpaired, and when there is insensibility or stiffness, then the animal is in a state of torpor, but not of hybernation. Again, though respiration is nearly suspended, the circulation still goes on; but, as it is of venous charac-

ter, and as it wants the usual impulse, Dr. Hall assigns it to a place in the scale of animal life which is lower than that of the reptiles. The phenomena which are thus presented come before us in a series of facts, which it would be difficult for us to believe, if they were not put beyond all dispute by undoubted evidence. Anatomy and pathology alone can explain the strange process, by describing the increased irritability of the left side of the heart. A very important distinction is drawn by Dr. Hall, between true hybernation and torpor. Torpor may be produced by cold in any animal, and is attended by a benumbed state of the sentient nerves, and a stiffened condition of the muscles; it is the product of cold. But hybernation is limited to a certain number of animals; in it sensibility and power of motion remain unimpaired; its phenomena are produced through the medium of sleep. The nature of hybernation is determined, in a great measure, by the fact, that all hybernating animals avoid exposure to intense cold; but choose a retreat, make nests or burrows, congregate sometimes in clusters. The instinct by which the animals are led to make use of precautions is in connection with the law which requires that the change from the condition of hybernations to that of activity shall be slow and gradual, in as much as the state of the blood in one condition is compatible with the peculiar power of the heart in the other. The object is learnedly treated by Dr. Hall, and is well worthy the attention of scientific men.

Sea-weed Banks.—The *Sargassum vulgare*, the tropic grape of sailors, and the Fucus natans of the older writers, is worthy attention, not only from its wandering habits, quitting as it does the submarine soil to which it probably in its early stage is attached, but also for the astonishing profusion in which it so frequently is found. It only grows within forty degrees of latitude on either side of the equator, but currents often cast it on our coast. It is a remarkable circumstance in the history of this plant, that it is chiefly located in its position, even when detached, forming two great banks, one of which is usually crossed by vessels homeward bound from Monte Video, or the Cape of Good Hope; and so constant are they in their places, that they assist the Spanish pilots to rectify their longitude. It is probable that these banks were known to the Phœnicians, who in thirty days' sail, with an easterly wind, came into what they called the "Weedy Sea;" and to the present day, by the Spaniards and Portuguese, the chief tract is named Mar de Zargasso. It was the entering of such fields of fucus as these that struck so much terror into the minds of the first discoverers of America; for sailing tardily through extensive meadows for days together, the sailors of Columbus superstitiously believed that the hindrance was designed by heaven to stay their adventurous course: hence they wildly urged their commander to proceed no further, declaring, that through the banks thus woven by nature, it would be presumptuous impiety to force a way.—[Burnett's Outlines of Botany.]

Birds and Insects.—There cannot be any question of the immense number of insects required by birds during the breeding season. It is stated by Bingley, that a pair of small American birds, conjectured to be the house-wren, were observed to leave the nest and return with insects from forty to sixty times in an hour, and that in one particular hour they carried food no fewer than seventy-one times. In this business they were engaged during the greatest part of the day. Allowing twelve hours to be thus occupied, a single pair of these birds would destroy at least six hundred insects in the course of one day, on the supposition that the two birds took only a single insect each time; but it is highly probable that they often took more.

Looking at the matter in this point of view, the destruction of insectivorous birds has in some cases been considered as productive of serious mischief. One striking instance we distinctly recollect, though we cannot at this moment turn to the book in which it is recorded. The numbers of the crows or rooks of North America were, in consequence of state rewards for their destruction, so much diminished, and the increase of insects so great, as to induce the state to announce a counter reward for the protection of the crows. Such rewards are common in America; and from a document given by Wilson, respecting a proposal made in Delaware "for banishing or destroying the crows," it appears that the money thus expended sometimes amounted to no inconsiderable sum. The document concludes by saying, "The sum of five hundred dollars being thus required, the committee beg leave to address the farmers and others of Newcastle county and elsewhere on the subject."

From its sometimes eating grain and other seeds, "the rook," says Selby, "has erroneously been viewed in the light of an enemy by most husbandmen; and in several districts attempts have been made either to banish it, or to extirpate the breed. But wherever this measure has been carried into effect, the most serious injury to the corn and other crops has invariably followed, from the unchecked devastations of the grub and caterpillar. As experience is the sure test of utility, a change of conduct has in consequence been partially adopted; and some farmers now find the encouragement of the breed of rooks to be greatly to their interest, in freeing their lands from the grub of the cockchafer, an insect very abundant in many of the southern counties. In Northumberland I have witnessed its usefulness in feeding on the larvæ of the insect commonly known by the name of Harry Longlegs, which is particularly destructive to the roots of grain and young clovers."

It has on similar grounds been contended, that the great number of birds caught by bird-catchers, particularly in the vicinity of London, has been productive of much injury to gardens and orchards. So serious has this evil appeared to some, that it has even been proposed to have an act of parliament prohibiting bird-catchers from exercising their art within twenty miles of the metropolis; and also prohibiting wild birds of any kind from being shot or otherwise caught or destroyed within this distance, under certain penalties. It is very clear, however, that such an act could never be carried; and though it *might* be advantageous to gardens, orchards, and farms, yet the attacks which the same birds make on fruit would probably be an equivalent counterbalance.

In the case of swallows, on the other hand, it has been well remarked by an excellent naturalist, (the Rev. W. T. Bree,) that they are to us quite inoffensive, while "the beneficial services they perform for us, by clearing the air of innumerable insects, ought to render them sacred, and secure them from our molestation. Without their friendly aid the atmosphere we live in would scarcely be habitable by man; they feed entirely on insects, which, if not kept under by their means, would swarm and torment us like another Egyptian plague. The immense quantity of flies destroyed in a short space of time by one individual bird is scarcely to be credited by those who have not had actual experience of the fact." He goes on to illustrate this from a swift, which was shot. "It was in the breeding season, when the young were hatched; at which time the parent birds, it is well known, are in the habit of making little excursions into the country to a considerable distance from their breeding places, for the purpose of collecting flies, which they bring home to their infant progeny. On picking up my hapless and ill-gotten prey, I observed a number of flies, some mutilated, others scarcely injured, crawling out of the bird's mouth; the throat and pouch seemed absolutely stuffed with them, and an incredible number was at length disgorged. I am sure I speak within compass when I state that there was a mass of flies, just caught by this single swift, larger than, when pressed close, could conveniently be contained in the bowl of an ordinary table-spoon." —[Library of Entertaining Knowledge.]

Effects of Burying Iron and Steel in the Earth.

Continued from page 261. [From the London Mechanics' Magazine for May.]

Sir,—I very much doubt whether we possess sufficient information to warrant the conclusion, that burying iron and steel in the earth "causes a decided improvement in its quality."

It is a subject that well deserves minute investigation. I think, however, it belongs to the practical worker in these metals, rather than the experimental chemist, to make the necessary observations. The chemist may be able to analyse a piece of metal, and to ascertain with tolerable accuracy of what materials it is composed;* but he will give very little useful information as to its utility, unless he be assisted by the experience of the man who forges, and tempers, and sharpens, the specimen, and thus exemplifies its peculiar properties.

That chemical changes are constantly going on in the vast and magnificent laboratory of nature, cannot, as I conceive, be denied. We must, however, bear in mind, that the chemistry of nature seems evidently designed to prepare materials for the chemistry of art to operate upon, and not to supercede the art itself.

The pile-shoes of London Bridge ought not to be cited as illustrative of a beneficial change by simply burying them in the earth. When those pile-shoes were forged, iron was a comparatively scarce metal. The small quantities of ore that were smelted in that day imply a careful and protracted process, evidently conducted under a variety of disadvantages as respects quantity, yet involving, perhaps, some

---

* The chemist who can do this must be more expert than a "Lecturer on Chemistry," of whose performances in the analytical way I have lately heard an amusing account.

of the most favorable conditions relative to quality.

The superiority of the straps that were in immediate contact with the charred surfaces of the piles, seems to indicate a process somewhat analogous to the cementation of iron in forming it into steel, by its combination with carbon. Yet, after all, may not this part of the shoe be that which had retained its original peculiarity, whilst that not in contact with the charred surfaces had become deteriorated by the soil in which it was imbedded?

It is to be feared that practical men, in the various departments of science to which they belong, are not sufficiently attentive to the phenomena that are constantly inviting their observation. Those of them who possess discernment enough to distinguish between things that differ, generally keep their own secrets. They are fully justified in doing so, whilst the present system of plundering and appropriating prevails in the scientific world. There is no very great encouragement for a poor man to communicate what he knows, merely to see others enriching themselves by the results of his unacknowledged, unappreciated, and unrewarded labors.

Your valuable correspondent "Junius" has said more of me than I deserve: were my means proportionate to my wishes, and I trust they are not immoderate, I should, perhaps, do more than I can at present. A young family, and a tolerably extensive business, justly demand of me the greater portion of my time and attention. A few moments of occasional leisure are all that I can spare to science; but those few moments always leave behind them a reward more satisfying and more enduring than either wealth or honor can confer.

I am, &c. J. O. N. Rutter.

April 30, 1833.

Internal Improvements, No. I. By F. To the Editor of the American Railroad Journal, and Advocate of Internal Improvements.

Sir,—Mechanical knowledge is now making rapid strides towards perfection, exercising in its progress a genial influence over the arts and sciences of the civilized world, strengthening its ties of intercourse, and dispensing plenty and intelligence where formerly misery and ignorance held their sway. The invention of the steam engine alone may be regarded as a new era in the domestic policy of nations, and since the important step made by Watt in reducing its principles to practical application by an investigation of its physical properties, its course has been steadily onward, engaging in its service more talent, ingenuity, and labor, and producing more national and individual wealth, than any other human invention. Its gradual development gave an impetus that has led to all the numerous discoveries and improvements in the different branches of manufactures, and raised them to their present high state of perfection. But a few years have elapsed when the wondrous effects now resulting from the application of this subtile fluid, before its capacity of adaptation was known, could only have found place to grace the pages of fiction, or adorn a tale of romance. Who would then have credited the assertion, if made, that hundreds were under its influence, daily travelling the country, navigating rivers, and traversing lakes and seas, at the rate of thirty miles per hour; and that at this high degree of velocity they were in the indulgence of every luxury and comfort that their own private apartments could afford? Had its accomplishment been then predicted, instead of serving as a beacon-light to guide the intelligence of men of science and learning, it would have been treated simply as the wild dream of an enthusiast, and elicited naught save contempt from many who are now proud to acknowledge themselves among its warmest advocates. For there are many persons still living, scarce passed the meridian of life, who blush to have regarded the idea as visionary; and, refusing the subject the effort of a thought, have even suspected the intellect of the person who predicted its eventual realization. Strange as this incredulity may now appear, it is none the less true; and a few years may yet prove to us that the principle is in its infancy; that it is destined to fulfil still higher duties; and that its sphere of usefulness is to be widely extended. It would be no unprofitable lesson to mark the influence which physical science, in its different stages, has exercised over the moral and political character of nations. It would be found that nearly in the same proportion that mechanics have advanced towards perfection, the world has advanced in civilization; that as its principles have been developed, its condition has been bettered; in short, it has been one of the grand moving principles by which these effects have been produced. But this investigation becomes not the present paper; and however grateful be the task to pay a passing tribute to the inventive talents and sublime genius of the great men who have preceded us, and laid the foundation on which the superstructure of civilization is being reared, it must be abstained from here to give place to the matter more immediately claiming our attention.

The astonishing change effected by the system of internal improvements, in the transition of persons and intelligence from place to place, has been productive of consequences not easily to be calculated. Distances being now estimated by *time* instead of *miles*, the mind and exertion of communities, hitherto isolated and deprived the benefits of free intercourse, become concentrated in proportion with the increased velocity of locomotion. A mutual dependance and interchange of commodities is established, which, in enlarging ideas and creating wants and desires before unknown, must operate beneficially as an incitement to increased activity for their accomplishment. It must be borne in mind that a portion of the price of every article

of necessity or luxury is composed of the cost of transporting it from producer to consumer; and consequently, that every reduction in this cost must produce a corresponding reduction in the price of the article transported. Should this portion be considerable in relation to the whole price of the manufactured article, it would be no difficult matter to demonstrate that its market value would be proportionably lessened; and as lessened, that its consumption would be proportionably increased. This observation is not confined to the home markets, but will likewise apply in its degree to the foreign, giving birth thereby to a spirit of competition, which alone, on either side, can stimulate the inventive genius of the operator to greater enterprize for the palm of mastery and the attainment of excellence.

Another consequence arising from increased cheapness and facility of transport, is a fresh demand for manufacturing population. All manufactured articles, as their uses become known, gradually cease to be regarded as luxuries, and enter more generally into the wants of every-day life. To meet the increased consumption necessarily attendant on this state of things, an increased number of operators must be employed; and this, in its re-action on the agricultural interests, will produce an extended market for that species of produce. Indeed, the benefit to the agriculturist is far greater than to the manufacturer; because the proportional expense of transporting all productions of the soil is much greater than that of transporting those of the loom, and in many instances enters so largely into its whole price as to preclude its cultivation, except for domestic purposes. To the agriculturist, therefore, it becomes a matter of still higher import that such means be devised as will place him on a more equitable footing with his more fortunate neighbors; and to this end he should, before the tide of prosperity has entirely run out and left him a prey to want, in some unfriendly shoal, direct his remaining energies to the accomplishment of such improvements of intercourse as nature and art may have placed at his disposal.

It is disagreeable to anticipate even in thought what might be the result of a continued deprivation of these facilities to any community, where indolence has taken the place of industry; and vice and misery, its usual concomitants, have breathed their pestilential influence over the actions of its members. Many a melancholy picture might be adduced in illustration from the experience of other countries, at the bare relation of which the heart of the philanthropist would sicken in sorrow; and many a parallel might have been deplored as a curse to this happy country, had not the soaring genius of a Clinton, in defiance of the vulgar prejudices of the day, predicted and finally executed a work that will command the admiration of ages, and stand a cenotaph to perpetuate his name to a grateful posterity. F.

New-York, 10th Nov. 1833.

No. II.

Sir,—To reflecting minds it is a matter of astonishment how little influence the dissemination of knowledge on this all important topic of interest has exercised in tempering the judgment of speculators; how little effect it has produced in the correction of errors that ignorance alone can palliate; and how little regard it has excited in the present as a warning against the experience of the past. This infatuation, if so it may be termed, in its effects so prejudicial to the true interest of the cause, is mainly ascribable to the spirit of rivalry, but has of late prevailed to such an extent among advocates of different modes of inland communication, that, until this spirit be quenched, it is much to be feared that examples, however numerous and fatal their consequences may be, will continue to pass by unheeded: the same errors will be committed, and the same rewards attend the acts of the designing stock-jobber. For it is this misplaced excitement that has caused the minds of men to stray from the path of common sense, and by bias of either one favorite project or another, led them into speculations, and realized blunders and mistakes, which, for absurdity and extravagance, can scarce find a parallel. It is now time that the reign of ignorance should cease, and that intelligence under the guidance of sound judgment should assume the sceptre, to mark out the path and direct our exertions to the development of those riches which nature has so prolifically bestowed on us.

The beneficial effects resulting from a well organized system of internal communications are now generally acknowledged by all classes, and it is therefore only necessary in this place to lay before you an investigation of the different means resorted to for producing those effects; and to point out, in as brief a manner as the nature of the subject will admit, their particular adaptation to the several cases in which they may be applied successfully for that purpose.

It was not until the time of the ancient Romans, that any material improvement was effected in the primitive means of intercourse between distant places. It was then, when extensive military operations demanded additional facilities for the transportation of armies with their necessary accoutrements, that the works known under the name of *Viæ Romanæ* were first introduced. These works are universally characterized by marks of grandeur, permanency and utility, that every succeeding age has admired, and which the havoc of time, during an interval of exceeding two thousand years, has scarce been able to efface. It may not be deemed irrelevant to our subject to occupy a few moments in noticing the *modus operandi* pursued in the construction of these noble monuments of antiquity; which, while serving as a parallel to judge that now adopted by modern nations, may, at the same time, act as a guide to their future improve-

ment. As to durability, we cannot hope to dispute the palm: and our claim to excellence, if any we have, must rest upon improved principles as modified by economy in construction. It must be remembered that the Romans were a warlike nation, despised commerce, and placed their whole reliance for maintenance in their scabbards; and in constructing works of this character, their advantages in a military point of view were alone regarded. If these could be made manifest, no obstacles of a fiscal nature could for a moment militate against their expectation. Men and means were forthwith provided, and the work was soon in a rapid state of progression. But the revolution that has since taken place, in the organization of civil society, renders the construction of similar works in one day next to impossible; and although we may no longer hope to see the spirit of former times emulated in the present, by the erection of monuments to ennoble our country and to record its genius, we may hand down to posterity such memorials and devices of the present age as the love of gain may suggest for the furtherance of individual interest.

But to return to our subject. These ways were commenced by making a deep excavation of the necessary width. Either side of this excavation was then protected by walls erected for the purpose, and crowned with parapets, to give solidity to the way, and to serve at the same time as an elevation for the convenience of those who travelled on foot. The space between the walls was then filled with layers of different materials, cemented together by a mortar made of the volcanic produce called puzzalano. Above these materials, thus formed into a solid bed, they placed the hardest stones that could be procured, constructing their salient angles so as to form a large mass, and cementing them together as before. At certain intervals they placed stones of a greater height than the parapets for the convenience of horsemen. The ways were then ornamented with temples, monuments, and shrubbery; and the distances marked on columns of stone. Some idea may be formed of the time and labor bestowed on these works, when it is remarked that, in the construction of the Appian-way, the hardest quality of stone was used that could be procured, which were smoothed and squared under the hands of the most skilful workmen, and joined together so nicely that the lines could scarcely be traced, and the appearance for miles was that of a single unbroken slab.

It is not contemplated in this place to trace the history of road making through its different gradations down to the present time; indeed, such a narration, independent of its want of interest, would be but a record of blunders founded on erroneous systems and mistaken principles. Telford and McAdam are undoubtedly the individuals of all others the most entitled to commendation for such improvements as now exist in the modern method of construction, and although the former's plan has since entirely given way before that of the latter, it still lays claim to some attention as an improvement on that of his predecessors, and perhaps as a preliminary step to the elucidation of those principles which were afterwards made known by his successor.

His plan consisted in first paving a foundation seven or eight inches in depth with rubble stone, laid in contact with each other on their flat and broadest sides, and paving their sharp points up. On these a covering of clean gravel and very small fragments of stone were laid to the depth of four inches, and rammed into the interstices of the paving until the whole was solidly imbedded in a mass. The road-bed presented by this process was sufficiently solid, but both more expensive and less enduring than that adopted by McAdam; and on a careful examination and comparison of the two methods, it will appear that it was moreover characterized by faults, on the absence of which all the fundamental principles of good road-making depend; and that, without their correction, no road, however faithfully executed, could possibly for any length of time retain its solidity of structure and evenness of surface. This, however, may be better explained after laying down Mr. McAdam's plan.

The stones most generally made use of in constructions after this plan are flint and limestone; the first because of its greater durability, the second because of its greater facility of amalgamation. These stones are to be broken in fragments of not exceeding two inches in thickness either way, and laid on a surface previously prepared for its reception by a covering of gravel to the depth of six inches. This is called the first layer, and is to remain for the space of two months, when a second layer of the same material and four inches in thickness is to succeed; and again, at the expiration of two additional months, a third layer, in all respects similar to the second, finishes the work. Due attention must be observed in the interim to preserve the surface even until the whole body becomes consolidated,—to prevent the introduction of round pebbles, which render a complete amalgamation of the angular stones impossible,—and, above all, to exclude from the superstructure, earth, clay, and chalk, which, being absorbents, either hold or conduct water to the soil, and thereby cause its speedy destruction. This system is based on the presupposition that the native soil, when perfectly free from moisture, is capable of sustaining any amount of pressure without yielding. A moment's reflection will convince of this fact, and once admitted as an axiom, it requires no further argument to demonstrate that the solidity of a road bears no proportion to, and is altogether independent of, the thickness of the superstructure, and that its permanency, where the crust has been rendered perfectly impervious to water, depends entirely on the character

of the stone used in its construction. It is a misapprehension on this important point that has been at the bottom of all the failures in the attempts at McAdamization made in this country. Stones are broken up in fragments of the requisite size, but sufficient care is not observed in the formation to exclude all such ingredients as can in any way act as conductors or absorbents. The mal-effect of the introduction of such ingredients is almost too obvious to need explanation. The moment that frost appears, the expansion, by congelation of the water absorbed, displaces the materials of which the road is composed, and thereby furnishes a passage to the soil for the deposite of under water. Directly this effect is produced the soil is effected, gives way, and deprives the crust of its natural support, when, as a consequence, it must necessarily go to ruin. The same effect is apparent in Telford's plan, by the introduction of *pebbles* in the superstructure; and the Romans, though guarding against it by the nicest workmanship, were evidently ignorant of the fundamental principle, that the native soil must sustain the whole pressure of the superincumbent weight.

The time that should elapse between the deposition of the different layers of the road is, of course, dependent on, and varies with, the amount of travel upon it. The principal care should be in a due observance that the surface of each distinct layer be preserved in a uniform state of smoothness, and that the layer be fairly consolidated before it is charged with the superincumbent covering.

A rigid adherence to these instructions cannot fail in producing a road of the greatest durability and uniformity of surface; and it is matter of no little surprize and vexation to us, that, notwithstanding the plain and simple manner in which McAdam has laid down and elucidated the principles of his system, and the particular directions which he has furnished for carrying them into execution, men should be found so pertinaciously bent on pursuing their own crude notions as to disregard them *in toto*, and, in violation of all common sense and experience, to multiply absurdities that the merest tyro might detect.

It is reasonable to ascribe the commission of these absurdities to the ignorance of superintendants; but if not, they must emanate from a less venial source: and, in either case, it is high time that such measures be taken as will place the construction of roads hereafter in more competent hands, so as to insure to the public, at least, a more satisfactory expenditure of their money, than, we regret to add, it has been their fate yet to acknowledge. The faults in Telford's plan have been fairly pointed out and explained—why not correct them? McAdam's system has been experimentally proved to be the best, whether it be regarded as to quality, durability, or economy in construction—then why not adopt it?

We might enlarge this subject to a much greater extent, and numerous examples might be adduced in corroboration of what is stated above concerning the inefficiency of persons engaged in the construction of public roads; but this Journal is already so rich in materials of this description, that it would be superfluous to add any thing further here, and we therefore take our leave in recommending the numbers alluded to to the careful perusal of all persons interested in the subject, with an assurance that their time will be fully compensated.

F.

New-York, Nov. 23, 1833.

On the Practical Effect of Undulating Railways. By J. S. Van De Graaff. To the Editor of the American Railroad Journal, and Advocate of Internal Improvements.

Sir,—In several recent numbers of your Journal I have observed a controversy, taken from the London Mechanics' Magazine, upon the subject of undulating railways. To determine the motion of an ordinary car, when propelled by any given moving power, upon a given inclined plane, agreeably to the received laws of gravity and friction, is a problem strictly determinable by analytical computation, and it is a little extraordinary that such a subject should have remained so long a matter of *dispute*, and referred at last to experiment for decision. The object of the present article is to deduce such results from the mathematical principles of natural philosophy, as will easily guide the engineer to a correct judgment of the practical effect of such a railway; and in order to avoid all those disputes which have arisen from the loose and unscientific method of reasoning hitherto given upon this subject, I must begin by demonstrating the theorems upon which the decision of the question will depend.

THEOREM I.

When railroad cars of the usual construction are in motion upon straight inclined planes, whether they be descending by the force of gravity, ascending by the force of inertia, or propelled by any moving power: I say, the resistance to motion, arising from the fricton of their axles, will vary in the direct ratio of the cosines of the inclinations of the planes; the weight of the cars and all other things being equal.

For in ordinary railroad cars there is no rubbing surface intervening between the point where the moving power is applied, and the point where its action takes effect upon the load; and, therefore, when such cars are drawn upon an ascending plane, the nominal pressure is that alone which is subject to any rubbing friction at the axle, with the exception only of the small force required in giving motion to the wheels and axles themselves. And in like manner the same thing may be shown to be true when the car is descending by the force of gravity, or ascending by the force of inertia; and hence the only sensible friction

at the axles, in every case, will be that which arises from the normal pressure alone, and which will be proportional thereto. But the normal pressure varies as the cosine of the inclination of the plane: see Courtney's Treatise on Mechanics, art. 265.—Therefore, when railroad cars of the usual construction," &c. &c. Q. E. D.

Corol. 1. And hence the friction at the axles will offer a reduced resistance to a moving power when the car is situated either upon the ascending or descending plane; but the horizontal and undulating ways are upon perfect equality as far as the accelerative force of gravity is alone connected, and it therefore follows, that any moving power considered separately from the effect of gravity, will act upon the undulating line with an effect greater than upon the horizontal line, in the given ratio of radius to the cosines of the inclination of each plane.

Corol. 2. But agreeably to the principles of trigonometry, the cosines of all arcs near the commencement of the quadrant will differ but little from radius, and the utmost practical limit of inclination must for many reasons fall within these arcs; and it therefore follows that the available reduction of friction by means of an undulating road cannot be of any practical utility in transporting upon railways. It would require an inclination of 25° 50½′ to reduce the friction at the axles even one-tenth part less than upon a horizontal road; and such an inclination, it is very well known, would be attended with difficulties in the practical use of the road, which would be much more formidable than the friction at the axle itself.

Scholium. The above reasoning will obtain in reference to cars of every description, when they are made to ascend a plane by the force of *inertia* only. But when a car is made to ascend a plane by a force different from *inertia*, it becomes necessary particularly to discriminate the points where the power is first applied, and where it takes effect upon the load; and it is a neglect of this consideration which has led into error a writer whose signature is S. D. (page 318, of this number,) when he supposes the friction at the axle to be a different quantity when the car is ascending and descending. All that is here said must be understood in reference only to cars whose construction is such as to give no rubbing surface intervening between the point where the power is applied and the point where its action takes place upon the load. The ordinary railroad car is of this description. But it will be easy to see that, with respect to a locomotive engine car, the case will be very different as far as the axle of the propelling wheels is concerned; for the friction of the bearings of the axle will be less when the engine is travelling upon a level road than when climbing a plane of any inclination. Nevertheless, the friction at the axle of the propelling wheels upon the plane will be less than when the engine is drawing a weight upon a horizontal road, which requires a force of *traction* equal to the gravity of the engine upon the plane.

In connection with the subject of undulating railways, there remains yet another principle to be considered. That is, the whole effect of the reduced friction at the axle upon the straight parts of the planes, as explained in the preceding theorem, will not be in all cases retained in passing the concave surface connecting the two planes; for unless the velocity of the car upon the curve be below a certain determinate limit, the whole quantity of motion destroyed by friction, in passing over the whole length of the curve, will exceed the quantity which would be destroyed in moving over the corresponding distance upon the horizontal road. This I now proceed to demonstrate.

THEOREM II.

When descending and ascending straight planes are connected together by a given concave circular surface: I say the motion of a car, in passing from the descending to the ascending plane, will be impeded by an increase of friction at the axle, which will be in a direct duplicate ratio of the velocity of the car.

For, the increase of friction at the axle will be proportional to the increase of pressure upon it; but the centrifugal force upon the curve is a normal pressure, which varies in a duplicate ratio of the velocity.—Therefore when descending and ascending straight planes, &c. &c. Q. E. D.

Corol. 1. It therefore appears that the friction at the axle of the car, when situated in the middle of the connecting curve, will be *greater* than the friction at the axle when the car moves upon horizontal rails, and this will be more the case as the car moves with greater velocity.

Such are the principles which must guide the engineer in an investigation of the effect of the proposed system of undulating railways. And in order to determine under what circumstances the ultimate amount of power consumed by friction upon the two planes and intermediate curve, is greater or less than the whole amount consumed by friction in moving over the corresponding distance upon the horizontal road, it would be necessary to enter into a minute analytical investigation of the circumstances under which the quantities of motion destroyed by friction in the two cases are equal. The principles of the differential and integral calculus will lead to this investigation without difficulty by means of the theorems given above, and which, therefore, for the sake of brevity, I may omit, for the results already given are sufficient to show that a material reduction of friction cannot be obtained by the undulating plan of construction, without using planes whose inclinations are altogether inadmissible in the practical use of railways.

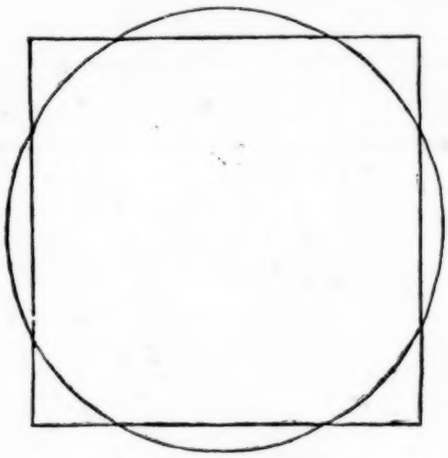
Although the chief object of the above investigation was an inquiry into the effects of an undulating railway, yet it may be observed,

that by means of the principles here demonstrated, it will be easy to deduce more accurate *formulas* for determining the amount of power required in moving railroad cars up an *inclined plane*, than has hitherto been given by Mr. Wood, and other writers.

Very respectfully,

J. S. Van De Graaff.

Lexington, Ky. Nov. 15, 1833.



Mechanical Quadrature of the Circle. By William Baddeley. [From the London Mechanics' Magazine.]

Sir,—The accompanying diagram exhibits a mechanical quadrature of the circle effected by Mr. Heaton, which I believe to be quite original; the rule thereby obtained is sufficiently accurate for all practical purposes. From a piece of carefully rolled sheet brass was cut out a circle 1·9 inches diameter, and a square of 1·7 inches. On weighing them they were found to be of exactly the same weight, which proves that as each are of the same thickness, the surfaces must also be precisely similar. The rule, therefore, is that the square is to the circle as 17 is to 19. Mr. Heaton made a number of experiments before he hit upon the right measurement, which he has at length determined with as much accuracy as the case will admit of.

I am, sir, yours, very respectfully,

William Baddeley.

London, Aug. 19, 1833.

Indelible Coloring.—In impregnating, in an even manner, the surface of cloth with a solution of nitrate of silver, and after drying it immersing the cloth in a solution of hydrochlorate, or of chloride of lime, chloride of silver is formed, which adheres strongly to the fibre, and if afterwards the cloth is exposed to the light, it immediately acquires a bluish gray tint, very clear and agreeable, which resists the action of chlorine, ammonia, &c. In order that it may be perfectly uniform, the whole piece must receive the action of the sun's rays at the same time. —[M. Robiquet, Jour. de Pharm.]

Extinguishing Fires by Steam.—On Thursday night an experiment, calculated to show the utility of steam in extinguishing fires, was exhibited at Mile End, Glasgow, on the premises of Mr. Clark. In a house fifteen feet by fifteen feet and ten high, combustible materials were put in the four corners and centre, and set on fire, and allowed to burn till the flames reached a height of about nine or ten feet; steam was then admitted into the house, which extinguished the flames in less than two minutes, and on opening the door in a few minutes after, the burning was found to be completely extinguished.—[Scottish Guardian.]

Mechanics in China.—It is said there are in China, 25,000 shoemakers; 15,000 weavers; 16,000 carpenters and cabinet-makers; and 7,000 lapidaries, or cutters of precious stones.

Law of Patents—Important Decision.—*Boston, Nov.* 7.—An important patent case has been tried before the United States District Court, Judge Story, sitting in this city. It was an action for an infringement of a patent right in a machine for the manufacture of paper. The plaintiff was John Ames, of Springfield, one of the oldest and most extensive paper manufacturers in the United States, and the defendants, Howard & Lathrop, paper makers. Counsel for the plaintiff, B. Rand, and William Bliss; for defendants, Fletcher and George Bliss. The case was opened Wednesday week, and occupied the court until Tuesday afternoon. It was argued with great zeal and ability by the counsel, and Judge Story's charge was minute and unequivocally in favor of the plaintiff. The jury gave a verdict for the plaintiff—damages $412.50.

It is understood that the case will be carried up to the Supreme Court. It is said to be the most important patent case ever tried here, owing to the value of the machine, and the extent to which it has been appropriated by others. Mr. Ames invented the machine, and made his specification in 1823, but owing to some defect in the specification, his patent right did not accrue. Recently Congress passed an act reviving old inventions, the benefit of which had been lost to their authors, by new specifications. Mr. Ames complied with this law, and revived his old patent in 1833. In the meantime his machine had become almost universally used in the paper manufacture all over the

United States. It had superseded every other machine but one, and it is said that a capital of four millions is invested in the manufacture of paper, carried on by this invention. Its value may be supposed from the fact that it will take from the pulp and throw out a sheet of paper per minute.

The defendants were not aware that they were infringing a patent right, but the judge charged the jury that this made no difference as to the actual infringement. The action was brought for the use of two machines, and if the plaintiff is sustained on the appeal to the Supreme Court, a similar action will be maintained against all who use the invention without the consent of the patentee.

METEOROLOGICAL RECORD, KEPT IN THE CITY OF NEW-YORK,

From the 10th day of November to the 9th of December, 1833, inclusive.

[Prepared expressly for the Mechanics' Magazine and Register of Inventions and Improvements.]

Date.	*Hours.*	*Thermometr*	*Barometer.*	*Winds.*	*Strength of Wind.*	*Clouds from what direction.*	*Weather.*
Nov'r. 10..	6 a. m.	49	30.95	WSW—WNW	light		clear
	10	53	30.00	WNW	moderate		..
	2 p. m.	57	30.01	W—WSW	light		..
	6	52	30.06	WSW			..
	10	49	30.11	..	..		..
" 11..	6 a. m.	45	30.17	..	..	W by S	fair
	10	50	30.16	SSW	..	WSW	..
	2 p. m.	58	30.10	S—SSE	..	..	cloudy —rainy
	6	52	30.00	..	..	..	rain
	10	53	29.88	S	..	..	rainy
" 12..	6 a. m.	47	29.71	SW	moderate	..	cloudy
	10	58	29.68	WSW—W	fresh	..	.. —rainy
	2 p. m.	60	29.70	W	gale	..	fair
	6	52	29.82	..	strong		clear
	10	45	29.90	WSW	..		..
" 13..	6 a. m.	41	29.97	..—W by S	moderate		..
	10	46	29.99	W	strong	WNW	fair
	2 p. m.	50	29.98	W—WSW	fresh	..	..
	6	47	29.98	WSW	moderate		clear
	10	45	29.99	..	..		..
" 14..	6 a. m.	42	29.90	SSW	..		..
	10	51	29.85	..—S	..	SW	fair
	2 p. m.	58	29.75	S	fresh	SSW	..
	6	54	29 65	..	moderate	..	..
	10	49	29.58	..	light	..	..
" 15..	6 a. m.	43	29.48	WSW	moderate	..	cloudy
	10	44	29.50		..	..—WSW	rainy —fair
	2 p. m.	47	29.54		fresh	WSW	
	6	44	29.58		..		clear
	10	40	29.69		moderate		..
" 16..	6 a. m.	33	29.77		..	..	fair —clear
	10	39	29.80	SW by W	..	SW	..
	2 p. m.	43	29.79	WSW	fresh	..	fair
	6	36	29.80	..	..	SW by W	..
	10	34	29.84	SW by W	..		..
" 17..	6 a. m.	32	29.84	..	..	..	..
	10	36	29.84	WSW	..	WSW	.. —squally
	2 p. m.	41	29.78	..	moderate	..	..
	6	39	29.76	..	..	..	..
	10	38	29.82	..	..	..	..
" 18..	6 a. m.	35	29.98	SW by W	..		clear
	10	41	30.04	WNW—W	..	NNW	
	2 p. m.	44	30.05	W	..	W	fair
	6	40	30.12	..	..	W by S	..
	10	36	30.18	..	..	WSW	..
" 19..	6 a. m.	29	30.25	NW	..		clear
	10	36	30.25	..	..	NW	fair
	2 p. m.	40	30.21		..		..
	6	37	30.25		fresh		..
	10	34	30.28		..		..
" 20..	6 a. m.	31	30.37	WSW	moderate	W by S	..
	10	35	30.40	NW	..	W	cloudy
	2 p. m.	40	30.42	..	..	..	..
	6	37	30.47	..	..	..	fair
	10	34	30.50	..	..		clear
" 21..	6 a. m.	32	30.50	NNE			cloudy
	10	38	30.46	E by N	fresh		..
	2 p. m.	44	30.41	SSE	..	SE	..
	6	44	30.35	..	..	..	..
	10	44	30.30	..	moderate	..	..
" 22..	6 a. m.	44	30.05	..	..	..	rainy

CITY OF NEW-YORK—CONTINUED.

Date.	*Hours.*	*Thermometr.*	*Barometer.*	*Winds.*	*Strength of Wind.*	*Clouds from what direction.*	*Weather.*
Nov. 22..	10 a. m.	44	30.00	ESE	moderate	SW	rainy
	2 p. m.	40	29.95	N	..	..	rain
	6	42	29.90	NNW	..	..	fair
	10	40	29.89	..	..	..	..
" 23..	6 a. m.	36	29.90	WSW	..	WSW	..
	10	40	29.94	..	..	..	clear —smoky
	2 p. m.	46	29.90	W by S	..	..	.. ..
	6	44	29.97	WNW—WSW	..		.. ..
	10	42	30.05	WSW	..		..
" 24..	6 a. m.	40	30.18	..	light	..	cloudy
	10	43	30.19	..—W	..	..	fair
	2 p. m.	46	30.15	W by S—SW—W	moderate	..	cloudy
	6	42	30.15	SW by W	..	..	..
	10	42	30.12	..	light	..	hazy —rain
" 25..	6 a. m.	40	29.90	NE by E	moderate	..	rain
	10	41	29.83	..	fresh	ENE	.. scud from ENE
	2 p. m.	38	29.70	..	..	..	..
	6	38	29.60	..	strong	..	..
	10	37	29.58	..	moderate	..	cloudy —rainy
" 26..	6 a. m.	35	29.71	WNW	..	WSW	..
	10	36	29.81	..	strong	..	fair
	2 p. m.	36	29.91	..	..	..	..
	6	35	30.80	..	..		clear
	10	34	30.10	..	..		..
" 27..	6 a. m.	33	30.15	SW	moderate	SSW	fair
	10	40	30.20	..	..	..	..
	2 p. m.	44	30.01	..	..	..	..
	6	41	29.99	..	..	..	
	10	40	30.03	..	light		clear
" 28..	6 a. m.	38	30.18	WNW	..		..
	10	40	30.21	..	moderate	W by N	fair
	2 p. m.	40	30.23	W by N	..	..	..
	6	39	30.31	..	..	..	..
	10	35	30.30	..	..	..	..
" 29..	6 a. m.	31	30.30	ENE	..	..	cloudy —smoky
	10	36	30.25	..	..	SSW	.. — ..
	2 p. m.	42	30.21	E	..	..	.. — ..
	6	43	30.20	..	..	..	.. — ..
	10	42	30.20	..	..	..	fair
" 30..	6 a. m.	45	30.10	ENE	..		rainy —cloudy
	10	45	30.10	..	..		cloudy —rainy
	2 p. m.	41	30.05	NE—NNE	fresh	NNE	rain
	6	40	30.05	NNE	..	..	..
	10	39	30.05	N	..		cloudy
Decem. 1..	6 a. m.	39	30.03	NNW	moderate	NNW	..
	10	41	30.07	NW	light	..	..
	2 p. m.	45	30.03	..—NNW	.. — mod.	WNW—NNW	fair
	6	40	30.07	NNW	mod.—light	NNW	..
	10	39	30.09	..	..		clear
" 2..	6 a m.	36	30.18	NW—NNW	light	WSW	fair
	10	38	30 23	NNW	..	..	..
	2 p. m.	42	30.20	N—NNE	light—mod.	WSW / NNE—ENE	cloudy
	6	40	30.35	NE	moderate		rainy
	10	39	30.27	..	fresh		..
" 3..	6 a. m.	40	30.30	NE by E—ENE	..	ENE	cloudy
	10	41	30.33	ENE	..	..	rainy
	2 p. m.	42	30.30	NE by E	..	..	cloudy
	6	41	30.35	..	..	..	..
	10	41	30.35	..	..	..	..
" 4..	6 a. m.	39	30.34	NE	moderate	WSW	..
	10	40	30.36	..	..	.. / ENE	..
	2 p. m.	43	30.32	NE by E	..		..
	6	42	30.31	..	..		..
	10	41	30.35	..	..		..
" 5..	6 a. m.	40	30.36	N by W	faint		..
	10	41	30.38	NNW—WSW	..	N—slow	fair —cloudy
	2 p. m	43	30.36	WSW—N	..	NNW	cloudy
	6	44	30.36	N	..	NW	.. —fair —cloudy
	10	42	30.39		..	WNW	..
" 6..	6 a. m.	38	30.39	NNW—N		N—slow	.. —fair
	10	41	30.40	N		..	fair
	2 p. m.	44	30.40	NNE	light	NNW	..
	6	41	30.40	NE		..	..
	10	35	30.41	..		..	..

CITY OF NEW-YORK—CONTINUED.

Date.	*Hours.*	*Thermometr.*	*Barometer.*	*Winds.*	*Strength of Wind.*	*Clouds from what direction.*	*Weather.*
Decem. 7..	6 a. m.	32	30.49	NE	moderate	W by S / NNW	cloudy
	10	34	30.50	..		..	—fair
	2 p. m.	38	30.49	..		W by S / S	fair —cloudy
	6	37	30.48	..			cloudy
	10	37	30.50	..	..—fresh		..
" 8..	6 a. m.	41	30.30	ENE	fr'h—strong	E	rainy —scuds from E
	10	43	30.28	..	strong—gale	ENE	.. —rain
	2 p. m.	42	30.11	..	gale— / strong / —gale	S—mod'te / SE—brisk / ENE—swift	rain at 4—clouds partially open, and strong [gale*
	6	43	30.88	..—NE—NNE	fresh-mod.		cloudy —hazy
	10	41	30.81	N by E	moderate		hazy —fair
" 9..	6 a. m.	37	30.97	SW—WSW	fresh	WSW / NW	fair
	10	40	30.95	WSW	..		..
	2 p. m.	44	30.96	..	..	WSW	cloudy
	6	41	30.98	..	..	..	fair
	10	39	30.98	..	..	..	..

In October the, observations of winds fom the North-Eastern quarter, were 15½—from the South-Eastern, 23—from the South-Western, 54—from the North-Western, 44.

The observations of the direction of clouds or higher current, for the same month, were as follows: From the North-Eastern quarter, 12—from the South-Eastern, 5—from the South-Western, 77—from the North-Western, 33.

Maximum of the barometer 30.52 in.—Minimum, 29.30 in.—Range, 1.22 in.

In November, the observations of winds are, from the North-Eastern quarter, 23—from the South-Eastern, 11—from the South-Western, 74—from the North-Western, 36.

The higher currents during the same month were, from the North-Eastern quarter, 5—from the South-Eastern, 4—from the South-Western, 62—from the North-Western, 36.

Maximum of barometer 30.57 inches—Minimum, 29.48—Range, 1.09 inches.

* At Middletown, Connecticut, a distance of one hundred miles *to windward*, the crisis of the storm, on Sunday, 8th of December, was near five hours *later* than in this city.

METEOROLOGICAL RECORD, KEPT AT AVOYLLE FERRY, RED RIVER, LOU.

For the month of October, 1833—(*Lat.* 31.10 *N.*, *Long.* 91.59 *W. nearly.*)

[Prepared for the Mechanics' Magazine and Register of Inventions and Improvements.]

Date.	*Thermometer.*			*Wind.*	*Weather, Remarks, &c.*
1833.	Morn'g.	Noon.	Night.		
Oct'r 1	65	72	68	NW	clear—purple figs fine, gathered the last ripe
" 2	54	72	68	calm	..
" 3	56	78	71	..	.. —Red River rising
" 4	58	75	71	..	..
" 5	62	78	73	S—light	cloudy—evening, shower—from 8 p. m. steady heavy rain all night
" 6	70	76	68	calm	.. —and heavy showers all day
" 7	56	65	62	NE	.. morning—wind from N to NW—evening clear
" 8	48	68	61	calm	clear
" 9	59	72	68	..	.. all day
" 10	56	73	69	..	.. —night cloudy
" 11	60	74	72	S	.. —foggy morning—clear day
" 12	70	74	67	N—high	.. all day—night calm
" 13	52	72	67	calm	..
" 14	59	76	73	S	cloudy—shower at night
" 15	70	80	79	..	.. .. —and sunshine all day—night clear
" 16	76	85	77	..—high	clear—flying clouds—evening showers
" 17	63	70	61	W to NW	cloudy morning—from 10 a. m. clear and high wind
" 18	45	59	55	N	clear—rain at night
" 19	47	57	56	..—light	cloudy
" 20	43	49	44	..—high	clear
" 21	39	50	46	..	.. —white frost light
" 22	33	48	47	..	.. — .. .. severe
" 23	40	65	63	S—light	.. — .. .. light—evening calm and cloudy
" 24	54	75	73	..	.. —evening calm and clear
" 25	63	70	58	NE	..
" 26	42	68	61	SE—light	..
" 27	47	73	70	calm	..
" 28	50	63	50	N—high	..
" 29	39	54	49	calm	.. —light white frost
" 30	33	64	54	..	.. —severe .. .. —Red River at a stand
" 31	45	67	60	..	.. —light .. ..

Red River is now within 11 feet of high water mark—rose this month, 13 feet 2 inches.

FEB 2 1946